AECOM

Transport for New South Wales
16-Mar-2017

Victoria Street Station Upgrade

Noise and Vibration Impact Assessment

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Client: Transport for New South Wales

ABN: 18 804 239 602

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F+61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

16-Mar-2017

Job Number: 60488497

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Quality Information

Document Victoria Street Station Upgrade

Ref 60488497

Date 16-Mar-2017

Prepared by Mathew Simon / Rachel Foster

Reviewed by Gayle Greer

Revision History

Revision	Revision Date	Details	Authorised Name/Position	Signature
A	24-Feb-2017	Draft for TfNSW review	Gayle Greer	Signed in original
B	16-Mar-2017	Second draft	Gayle Greer	Signed in original
C	16-Mar-2017	Final	Gayle Greer	Gayle Greer

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1.0 Introduction

1.1 Background information

AECOM Australia Pty Ltd (AECOM) has been commissioned by Transport for New South Wales (TfNSW) to undertake a noise and vibration impact assessment of the construction and operation of the proposed Victoria Street Station Upgrade (the 'Proposal').

This noise and vibration impact assessment has been prepared to support a Review of Environmental Factors (REF), which has been prepared to assess the environmental impacts associated with the construction and operation of the Proposal under the provisions of Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Subject to approval, construction of the Proposal is expected to commence in mid-2017 and take around 18 months to complete. Works would be undertaken predominantly during standard construction hours, with low-noise impact cutover works occurring during rail shutdowns. Approximately six weekend rail shutdowns are likely to be required over the construction period.

The following policies and guidelines are relevant for this assessment:

- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change (DECC), 2009
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC), 2006
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011
- *NSW Industrial Noise Policy* (INP), Environment Protection Authority (EPA), 2000
- *Construction Noise Strategy* (CNS), TfNSW, 2011
- DIN Standard 4150: Part 3 1999 Structural Vibration in Buildings - Effects on Structures, 1999
- British Standard 6472: Part 1 2008 Evaluation of Human Exposure to Vibration in Buildings, 2008
- Australian Standard AS 2436-2010, Guide to noise and vibration control on construction, demolition and maintenance sites, 2010
- Australian Standard AS 1055.1-1997 – Acoustics – Description and measurement of environmental noise, Part 1: General procedures, 1997
- UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*, 2006.

Definitions for acoustic terminology used within this report can be found in **Appendix A**.

1.2 Scope

The scope of this noise and vibration impact assessment is to:

- establish the existing background noise levels in the vicinity of Victoria Street Station
- establish the construction noise management levels and vibration limits which would apply to the Proposal
- predict environmental noise and vibration levels at nearby residential and other sensitive receivers due to the Proposal
- predict noise impacts from additional off-site construction traffic generated by the Proposal
- recommend mitigation measures where necessary to reduce and manage noise and vibration impacts from the Proposal
- consider noise from the operation of the upgraded Victoria Street Station.

1.3 Proposed works

The Proposal would include the following key elements:

- installation of three new lifts to provide access to the existing footbridge and island platform
- new canopies installed at both station entrances and along the existing footbridge, stairs, lift landings and platform
- upgrades to the northern and southern station entrances
- refurbishment of the Platform Building with a new family accessible toilet, staff amenities and communications room to replace existing facilities
- provision of new undercover bicycle racks on the northern and southern side of the station
- provision of a new accessible parking space, kiss and ride area and taxi rank on the northern side of the station on Waller Street
- new kerb ramps to provide an accessible path of travel to new and existing interchange facilities
- relocation of existing and installation of new services including communications systems and low and high voltage electrical cabling
- ancillary works including platform stabilisation and regrading, station power supply upgrade, minor drainage works, adjustments to lighting, upgrades to fencing and landscaping, new ticketing facilities including additional Opal card readers, improvement to station communication systems (including CCTV cameras) and wayfinding signage.

A detailed description of the Proposal is provided in Chapter 3 of the Victoria Street Station Upgrade Review of Environmental Factors (REF).

1.4 Site description

1.4.1 Proposal location

Victoria Street Station is located within a mixed use environment comprising predominantly residential properties to the north, east and south with some commercial buildings to the west of the station. There are several medical and educational facilities within one kilometre of the station. The closest residential receivers are located immediately adjacent to the north of the Proposal on Waller Street and Lindesay Street, with other residential receivers located to the south on Victoria Street and Charles Street and to the west on Myra Street. The Lifehouse Church is located to the south west of the Proposal. There are a number of other sensitive receivers in the local vicinity including 24/7 Family Day Care, Kindy Patch Emmas and Fieldsend Early Learning Centre child care centres. The station and surrounding environment is shown in Figure 1.

Victoria Street and Lawes Street are considered to be sub-arterial roads and Newcastle Street/New England Highway is considered to be an arterial road, as per categories within the Environment Protection Authority's (EPA) *NSW Road Noise Policy*.

1.4.2 Representative receivers

To simplify the assessment methodology, 36 representative residential receivers have been selected to describe the noise impacts within areas considered likely to have similar background noise levels. Residences located closest to the Proposal were selected as the potentially worst affected receivers. These receivers are listed in Table 1.

Impacts were also assessed at representative non-residential receivers, including schools, places of worship and medical centres. These receivers are listed in Table 2.

The locations of the residential and non-residential receivers identified for use in the assessment are presented in Figure 2. It is noted that other residential and non-residential receivers which could potentially be affected by the Proposal are scattered around the vicinity of the Proposal location.

1.4.3 Noise catchment areas

To assist in determining noise criteria for the receivers surrounding the Proposal, two noise catchment areas (NCA) were identified. Refer to Section 2.3 for a description of NCAs. The noise environment at each of the residential receivers within the NCA is considered to have a similar noise environment. The NCAs are shown in Figure 1.

1.4.4 Heritage items

Victoria Street Railway Station Group is listed on the State Heritage Register (SHR), the RailCorp Section 170 Heritage and Conservation Register and the Maitland Local Environmental Plan (LEP) 2011. The station has heritage significance as a tangible link to the development of the Main North line as the original terminus of the line from Newcastle from 1857 to 1858 and for its demonstration of the increase in rail services at the time of duplication through the conversion of the platform into an island platform. The Platform Building and existing footbridge are representative examples of railway design throughout NSW during the early twentieth century.

Refer to the Victoria Street Station Upgrade Statement of Heritage Impact (AECOM 2017) for more information.

Table 1 Representative receiver addresses – residential

Receiver ID	Receiver address	Approximate distance to Proposal (metres)
R1	66 Victoria Street, East Maitland	27
R2	65 Victoria Street, East Maitland	55
R3	3-5 Waller Street, East Maitland	32
R4	2 Myra Street, East Maitland	29
R5	1 Charles Street, East Maitland	104
R6	60 Victoria Street, East Maitland	38
R7	3 Porter Avenue, East Maitland	37
R8	85 High Street, East Maitland	132
R9	68 Lindesay Street, East Maitland	130
R10	1-3 Raymond Terrace Road, East Maitland	113
R11	87 High Street, East Maitland	152
R12	2 Raymond Terrace Road, East Maitland	157
R13	149 Lawes Street, East Maitland	265
R14	22 Burg Street, East Maitland	251
R15	24 Brunswick Street, East Maitland	215
R16	2 Brunswick Street, East Maitland	207
R17	52 Lindesay Street, East Maitland	262
R18	81 George Street, East Maitland	263
R19	85 George Street, East Maitland	289
R20	48 Lindesay Street, East Maitland	329
R21	169 Lawes Street, East Maitland	367
R22	123 High Street, East Maitland	344
R23	42 Victoria Street, East Maitland	339
R24	36 Hunter Street, East Maitland	371
R25	40 Lindesay Street, East Maitland	421
R26	43 High Street, East Maitland	410
R27	41 Day Street, East Maitland	454
R28	2 Alliance Street, East Maitland	425
R29	253 Newcastle Street, East Maitland	611
R30	7 Bruce Street, East Maitland	548
R31	239 Newcastle Street, East Maitland	615

Receiver ID	Receiver address	Approximate distance to Proposal (metres)
R32	22 Paterson Street, East Maitland	574
R33	23 High Street, East Maitland	610
R34	279 Newcastle Street, East Maitland	690
R35	21 Day Street, East Maitland	694
R36	31 Page Street, East Maitland	729

Table 2 Representative receiver addresses – non-residential

Receiver ID	Receiver address	Use	Approximate distance to Proposal (metres)
N1	Lifehouse Church, 61 Victoria Street, East Maitland	Place of worship	4
N2	Noodle Bar, 98A High Street, East Maitland	Commercial	127
N3	East Maitland Medical Centre, 21 Myra Street, East Maitland	Medical	147
N4	East Maitland Chiropractic, 91 High Street, East Maitland	Medical	170
N5	Laverty Pathology, 136 Lawes Street, East Maitland	Medical	218
N6	St Stephens Presbyterian Church, 64 George Street, East Maitland	Place of worship	225
N7	Cassim K M, 90 George Street, East Maitland	Medical	231
N8	DR Peters Surgery, 92 George Street, East Maitland	Medical	239
N9	24/7 Family Day Care, 121 High Street, East Maitland	Child Care	299
N10	Bravo Health and Skin, 121 Lawes Street, East Maitland	Medical	305
N11	Maitland High School, 13A Hunter Street, East Maitland	School	507
N12	King Street Community Pre School, 50 King Street, East Maitland	School	462
N13	6 Young Street, East Maitland	Industrial	429
N14	Kindy Patch Emmas, 61A Narang Street, East Maitland	Child Care	547
N15	St Joseph's Primary School, 55 King Street, East Maitland	School	583
N16	Fieldsend ELC, 34 Fieldsend Street, East Maitland	Child Care	591
N17	St Joseph's East Maitland Church, 73 King Street, East Maitland	Place of worship	653
N18	East Maitland Private School, 38 Fieldsend Street, East Maitland	School	613
N19	Maitland East Public School, 28 William Street, East Maitland	School	747

Figure 1 Noise and vibration sensitive receivers and noise logger locations

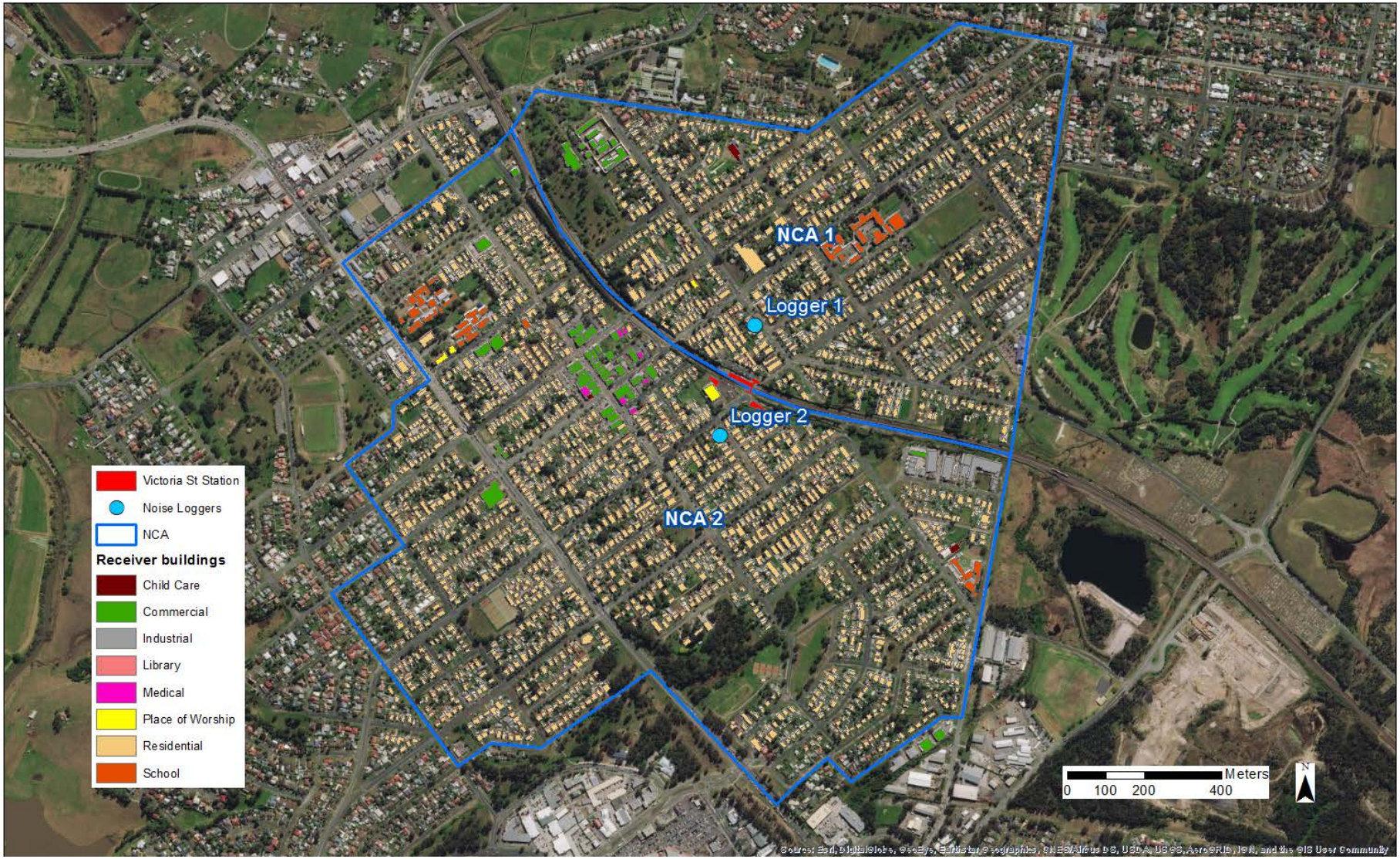


Figure 2 Representative residential and non-residential receiver locations

2.0 Existing acoustic environment

Long term unattended measurements were undertaken to establish the existing ambient and background noise environment at potentially affected receivers in the vicinity of the Proposal.

2.1 Noise measurement methodology

Long term unattended noise monitoring was conducted at two locations between 3 and 11 March 2016. One noise logger was placed within each NCA at a representative location as identified in Table 3 and shown in Figure 1. The noise loggers were calibrated prior to and after the monitoring period with a drift in calibration not exceeding ± 0.5 dB.

Attended noise measurements were not undertaken for this site as it was considered that the results of the unattended noise monitoring would provide sufficiently robust data on which to base the relevant environmental noise criteria. During the installation of the unattended noise monitoring equipment, the nature of the existing ambient noise environment was noted and the major existing noise sources were identified. This information is presented in Section 2.3.

All the acoustic instrumentation employed during the noise measurements comply with the requirements of *AS IEC 61672.1-2004 Electroacoustics - Sound level meters - Specifications* and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

Table 3 Unattended noise monitoring details

NCA	Logger	Location	Model	Serial number
1	1	59 Lindesay Street, East Maitland	Cirrus 171	G061710
2	2	3 Charles Street, East Maitland	Rion NL52	164395

These unattended logger locations were selected as being representative of typical existing background noise environments for the two noise catchment areas, being located at similar distances from major noise sources (rail, arterial / sub-arterial roads).

The noise environment at each of the residential receivers within a NCA is considered to have a similar noise environment to the unattended monitoring location with that NCA. As such each of these residential receivers is assigned the same background noise level and construction noise management level.

In accordance with the EPA's *NSW Industrial Noise Policy* (INP), noise monitoring affected by adverse weather conditions or extraneous noise events was excluded from the monitoring data. The INP advises that data may be affected where adverse weather, such as wind speeds higher than five metres per second or rain, occurs. Weather data was acquired from the Bureau of Meteorology's Cessnock Airport weather station (station ID 061260) located around twenty five kilometres south west of the Proposal.

2.2 Unattended noise measurements

The loggers measured the noise levels over the sample period and then determined L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The $L_{A1,}$ L_{A10} and L_{A90} noise levels are the levels exceeded for 1%, 10% and 90% of the measurement period respectively. The L_{A90} is taken as the background level. The L_{A1} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the INP for each monitoring location. The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. Table 4 and Table 5 present individual ABLs for each day's assessment periods for each NCA. The background noise level or rating background level (RBL) representing the day,

evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring period.

Table 4 and Table 5 also present the existing L_{Aeq} ambient noise level selected for each day, evening and night-time period, in accordance with the INP for each NCA. An overall representative L_{Aeq} noise level is determined by logarithmically averaging each assessment period for the entire monitoring period. Graphical noise logging results are presented in Appendix B.

Table 4 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels – NCA 1

Measurement date	L_{A90} Background noise levels, dB(A)	L_{A90} Background noise levels, dB(A)	L_{A90} Background noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Thursday 3 March 2016	49	45	40	64	66	62
Friday 4 March 2016	45	44	39	66	62	56
Saturday 5 March 2016	41	42	39	62	59	57
Sunday 6 March 2016	43	42	37	64	64	56
Monday 7 March 2016	42	43	41	64	59	57
Tuesday 8 March 2016	46	44	39	64	60	57
Wednesday 9 March 2016	41	43	41	64	62	57
Thursday 10 March 2016	44	-	-	64	-	-
Rating background level	**43**	**43**	**39**	**-**	**-**	**-**
Log Average L_{Aeq}	**-**	**-**	**-**	**64**	**62**	**58**

Notes:
1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays.
   Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays.
   Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

Table 5 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels – NCA 2

Measurement date	L_{A90} Background noise levels, dB(A)	L_{A90} Background noise levels, dB(A)	L_{A90} Background noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Thursday 3 March 2016	36	44	39	53	53	52
Friday 4 March 2016	39	42	33	53	54	51
Saturday 5 March 2016	34	39	34	54	55	53
Sunday 6 March 2016	39	38	35	54	52	51
Monday 7 March 2016	35	45	38	52	54	53
Tuesday 8 March 2016	40	43	38	56	55	51
Wednesday 9 March 2016	34	41	37	53	53	51
Thursday 10 March 2016	36	37	33	53	52	51
Friday 11 March 2016	36	-	-	53	-	-
Rating background level	**36**	**41 (36)[2]**	**36**	**-**	**-**	**-**

Measurement date	L_{A90} Background noise levels, dB(A)	L_{A90} Background noise levels, dB(A)	L_{A90} Background noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)	L_{Aeq} Ambient noise levels, dB(A)
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Log Average L_{Aeq}	**-**	**-**	**-**	**54**	**54**	**52**

Notes:
1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays.
   Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays.
   Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.
2. Application notes to the INP indicate that the community generally expects a greater control of noise during the evening and night as compared to the day time. Therefore the evening noise level is set to no more than that for the daytime.

2.3 Existing noise environment summary

The acoustic environment of NCA 1 is characterised by a mixture of local traffic, particularly Lindesay Street and natural sounds. Trains were not observed during the installation of the noise monitoring equipment at logger location 1, but are likely to be audible in close proximity to Victoria Street Station.

The acoustic environment of NCA 2 is characterised by a mixture of natural sounds and local traffic, with vehicles accessing the commuter car park along Victoria Street on the southern side of the station controlling the ambient noise levels. Trains were not observed during the installation of the noise monitoring equipment at logger location 2, but are likely to be audible in close proximity to Victoria Street Station. There was some influence from traffic on Lawes Street.

These characteristics are typical of a suburban environment. For NCA 2, the evening background levels are generally higher than the daytime background levels. This is likely due to a traffic peak in the evening as people travel home from work.

The noise monitoring results at both NCAs indicated lower noise levels during the night, compared to day and evening periods. This is again typical of a suburban environment.

3.0 Construction noise and vibration criteria

3.1 Construction activity noise criteria

3.1.1 Interim Construction Noise Guideline

The EPA's *Interim Construction Noise Guideline* (ICNG) is the principal guideline for the assessment and management of construction noise in NSW. This document replaces the previous publication the *Environmental Noise Control Manual* and is used as the basis for establishing construction noise management levels.

The ICNG recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the Environmental Impact Assessment (EIA) processes'. Noise levels due to construction activities are predicted at nearby receivers using environmental noise modelling software and compared to the levels provided in Section 4 of the ICNG.

Where an exceedance of the management levels is predicted, the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practises to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as contact details.

Where construction noise levels reach 75 dB(A) residential receivers can be considered as 'highly noise affected' and the proponent should, in consultation with the community, consider restricting hours to provide respite periods.

The ICNG defines what is considered to be feasible and reasonable as follows:

- *"Feasible*

  A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

- *Reasonable*

  Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."

The construction noise management levels (NML) for the residential and other sensitive land uses are detailed in Table 6, Table 7 and Table 8.

Table 6 ICNG residential noise management levels

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. – where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level – the proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. – where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + five dB	– a strong justification would typically be required for works outside the recommended standard hours – the proponent should apply all feasible and reasonable work practices to meet the noise affected level – where all feasible and reasonable practices have been applied and noise is more than five dB(A) above the noise affected level, the proponent should negotiate with the community – for guidance on negotiating agreements see section 7.2.2 of the ICNG.

Notes:

1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metres above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 7 presents the NMLs applicable to residential receivers nearby to the Proposal.

Table 7 Construction noise management levels – Residential receivers

NCA	Period	RBL, L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels, $L_{Aeq,15min}$, dB(A)
1	Day	43	53	48
	Evening	43	N/A	48
	Night	39	N/A	44
2	Day	36	46	41
	Evening	36	N/A	41
	Night	36	N/A	41

Table 8 presents the NMLs applicable to other non-residential noise sensitive receivers such as educational facilities, places of worship. NMLs applicable to commercial receivers are also presented in Table 8.

Table 8 Construction noise management levels – Non-residential receivers

Land use	Noise management levels, $L_{Aeq,15min}$ (applies when properties are in use)
Classrooms at schools and other educational institutions	55 dB(A)[1]
Places of worship	55 dB(A)[1]
Childcare centres	55 dB(A)[1]
Medical centres	55 dB(A)[1]
Commercial premises (including offices, retail outlets)	70 dB(A)
Industrial premises	75 dB(A)

Notes:
1. These external management levels are based upon a 45 dB(A) internal noise management level and a 10 dB reduction from outside to inside through an open window.

3.1.2 Sleep disturbance criteria

The ICNG requires a sleep disturbance analysis where construction works are planned to extend over more than two consecutive nights. On the basis of the ambient noise environment during the night-time period, the predicted L_{A1} noise levels and number of expected L_{A1} noise events should be predicted in order to determine the likelihood of potential sleep disturbance.

The ICNG makes reference to the NSW *Environment Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999), now superseded by the *Road Noise Policy* (RNP), for guidance in assessing the potential for sleep disturbance.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the $L_{A1(1\ min)}$, noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB. The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is exceeded, a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, 'Maximum internal noise levels below 50 to 55 dB(A) are unlikely to cause awakening reactions'. Therefore, given that an open window provides approximately 10 dB in noise attenuation from outside to inside, external noise levels of 60 to 65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 9.

Table 9 Sleep disturbance criteria

NCA	Background noise level (L_{A90}), dB(A)	Sleep disturbance criteria	$L_{A1(1\ minute)}$, dB(A)
		Screening level	Awakening reaction
1	39	54	60 – 65
2	36	51	60 – 65

3.2 Construction traffic noise criteria

Noise from construction traffic on public roads is not covered by the ICNG. However the ICNG does refer to the ECRTN, now superseded by the RNP, for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction traffic or a temporary reroute due to a road closure or both, an initial screening test should be undertaken by evaluating whether existing road traffic noise levels will increase by more than two dB(A). Where the predicted noise increase is two dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than two dB(A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

Victoria Street provides the main road access to the Proposal from the north (via Waller Street) and the south, and is likely to be accessed via Newcastle Street, with secondary access from Lindesay Street. These roads are classified as sub-arterial (Victoria Street, Lindesay Street), and arterial (Newcastle Street).

The external noise criteria are applied one metre from the external façade of an affected building.

3.3 Construction vibration criteria

The relevant standards and guidelines for the assessment of construction vibration are summarised in Table 10.

Table 10 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration)	*Assessing Vibration: A Technical Guideline* (AVATG) [1]

Notes:
1. This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "*Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting*" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the EPA still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities
- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

3.3.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

The German Standard (DIN 4150) provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 11.

DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage. For the purpose of this assessment, DIN 4150 limits have been adopted for residential, non-residential and heritage structures.

Table 11 DIN 4150: Structural damage safe limits for building vibration

Group	Type of structure	At foundation (less than 10 Hz)	At foundation (10 Hz to 50 Hz)	At foundation (50 Hz to 100 Hz[1])	Vibration at the horizontal plane of the highest floor for all frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or use.	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order/heritage listed).	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

Notes:

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values.

3.3.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline A*ssessing Vibration: A Technical Guideline* (AVTG) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 12. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 12 Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$) for daytime (7am – 10pm) and night time (10pm – 7am)

Location	Daytime Preferred	Daytime Max	Night time Preferred	Night time Max
Critical areas[1]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops[2]	0.8	1.6	0.8	1.6

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. Places where sensitive equipment is stored or delicate tasks are undertaken require more stringent criteria than the residential criteria specified above.
2. Examples include automotive repair shops, manufacturing or recycling facilities. This includes places where manufacturing, recycling or repair activities are undertaken but do not require sensitive or delicate tasks.

4.0 Operational noise criteria

4.1 Industrial Noise Policy

The *NSW Industrial Noise Policy* (INP) provides guidance in relation to acceptable noise limits for industrial noise emissions, including from railway stations. The assessment procedure in the INP has two components: the intrusive and amenity criteria. The more onerous criterion is then adopted as the project specific noise level which the Proposal is assessed against. Both components are assessed at the boundary of the noise sensitive receiver site, or if the site boundary is more than 30 metres from the noise sensitive building, a distance of 30 metres from the noise sensitive building.

Adjustments to the level of noise predicted at the assessment location should be applied in accordance with Section 4 of the INP to account for the subjective effects of specific noise characteristics including tonality, low frequency content, intermittency, impulsiveness and duration.

The intrusive criterion is intended to protect residential receivers against intrusive noise impacts in the short term. The INP states that the noise from any single noise source should not be greatly above the prevailing background noise level. Industrial noise sources are generally considered acceptable if the A-weighted equivalent continuous sound pressure level of noise from the source, measured over a 15 minute period ($L_{Aeq,15\ min}$) does not exceed the Rating Background Level (RBL) by more than five dB(A) for the period under consideration. This is termed the intrusiveness criterion. The RBL is the background noise level to be used for assessment purposes and is determined by the methods given in the INP.

The amenity criterion is intended to maintain noise level amenity and limit cumulative noise increases for residences and other land uses. To limit continuing increase in noise levels, the maximum ambient noise level within an area from all industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. That is the noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the “background creep” or “amenity criterion”. The amenity criterion is measured over the entire daytime, evening or night-time period.

A summary of the environmental noise criteria is presented in Table 13. These criteria apply to environmental noise emissions from any operational plant installed as part of the Proposal.

Table 13 Summary of environmental noise emission criteria

Location	Time of day	RBL dB(A)	Intrusive Criterion $L_{Aeq(15\ min)}$, dB(A)	Amenity Criterion $L_{Aeq(period)}$, dB(A)	Project-Specific Noise Levels Criterion [1] L_{Aeq}, dB(A)
NCA 1	Day	43	48	55	48
	Evening	43	48	45	45
	Night	39	44	40	40
NCA 2	Day	36	41	55	41
	Evening	36	41	45	41
	Night	36	41	40	40
School classroom	Noisiest one hour period when in use	-	-	45[2]	45
Place of Worship	When in use	-	-	50[2]	50
Commercial premises	When in use	-	-	65	65
Industrial premises	When in use	-	-	70	70

Notes:

1. Project-Specific Noise Levels represent the lower of the intrusive and amenity criteria.
2. External noise level assuming windows are open for adequate ventilation.

5.0 Construction noise assessment

5.1 Construction stages and scheduling

In consultation with TfNSW, five distinct work packages consisting of a number of construction activities have been assumed to be required for the upgrade works. These would be confirmed by the construction contractor prior to construction commencing and further assessment would be undertaken if required. Proposed construction stages for the works are described in Table 14. The proposed timing of the works is also presented in this table.

Table 14 Construction stages and scheduling

Construction stage	Activity	Timing
1 - Site establishment and enabling works	**1A – Establishment of site compound** Establishment of site compound (erect fencing, tree protection zones, site offices, amenities and plant/material storage areas) Establishment of temporary facilities as required (e.g. temporary pedestrian access to station, temporary toilets)	Standard hours or day time shutdown
	1B – Removal of vegetation Removal of identified vegetation along Waller Street	Standard hours
	1C – Services relocation	Mostly standard hours, with cutover works (not noisy) during shutdown
2 – Platform stabilisation	**2A – Installation of horizontal anchors**	Standard hours or 48 hour shutdown
	2B – Installation of inclined anchors	Standard hours or 48 hour shutdown
3 – New lifts and platform upgrade	**3A – Platform modifications** Platform modifications, lift shaft installation including piling and foundations for lift shaft	Standard hours or 48 hr shutdown
	3B – Construction of lift shafts Construction of lift shaft, stairs, fencing and new canopies	Standard hours or 48 hr shutdown
	3C – Installation of lifts and fixtures Installation of lifts Installation of fixtures, lighting, signage and CCTV cameras for the station areas	Standard hours or day time shutdown
4 – Platform Building reconfiguration works	**4A – Reconfiguration of Platform Building** Reconfiguration of the Platform Building to allow for communications/equipment room, staff facilities and toilets including a family accessible toilet	Standard hours
	4B – Refresh of Platform Building Refresh of Platform Building including painting works	Standard hours or 48 hour shutdown
5 - Interchange works	**5A – Interchange works** Installation of accessible car spaces, taxi and kiss and ride facilities, new kerb ramps and bicycle racks	Standard hours
	5B – Ancillary works and commissioning Installation of wayfinding signage Electrical and power supply upgrade works Replanting/landscaping, fencing adjustments and bollards Installation of 315 kVA transformer – adjacent to 60	Standard hours

Construction stage	Activity	Timing
	Victoria Street Trenching for 11 kVA cable – along Victoria Street and east on Lindesay Street	

Out-of-hours works would likely be required during around six weekend rail shutdowns over the 18 month construction period and potentially during some evening/night-time periods to minimise traffic impacts. This would provide some respite periods during weekdays between works.

5.2 Construction noise sources

Construction noise sources and their respective L_{Aeq} sound power levels for each scenario are shown in Table 15. These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites* and the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites* noise database and assume equipment is modern and in good working order.

Table 15 Equipment sound power levels per construction stage

Equipment	Sound Power Level[1] (dB(A))	Construction stage
Bobcat	104	1A, 1B, 2A, 5A, 5B
Chainsaw	110	1B
Concrete mixer	89	2B, 5B
Concrete pump	106	2B, 3A, 3B, 5A, 5B
Concrete truck	106	3A, 3B, 5A
Coring machine	113	5B
Demolition saw	110	3A, 3B, 4A
Drilling rig	107	2B
Excavator	94	1C, 3A, 3B, 4A
Franna crane	93	3A, 3B
Gardening tools	-	5B
Generator	93	1A, 3A, 3B
Grinder	108	3B, 4A
Hand tools	94	1A, 1B, 1C, 2A, 3A, 3B, 4A, 4B, 5A, 5B
Hydreama and / or Hirail	98	3A, 3B
Jack hammer	108	3A, 3B, 4A, 5B
Lighting tower	93	3A, 3B, 4B
Manitou	92	3B
Mini excavator	94	2A, 5A, 5B
Mobile crane	104	3B, 5B
Mulcher	120	1B
Piling rig	103	3A
Nail gun	94	4A

Scissor lift	100	3B, 4B
Trucks	98	1A, 1B, 1C, 2A, 3A, 3B, 4A, 5A, 5B
Vibration plate	104	2A

Notes:

1. Sound powers are time weighted (i.e. weighted for 'on time' during a typical 15 minute period)

5.3 Modelling and conditions

In order to assess noise impacts from the Proposal during construction, a noise model was created to represent 'reasonable' worst periods of upgrade works. The construction of the Proposal has been modelled in SoundPLAN Version 7.3 with the following features included in the noise model:

- ground topography (the level and shape of the surrounding land)
- ground absorption and reflection
- buildings (including shielding of noise) (shown in Figure 1)
- residential and non-residential receivers (as shown in Figure 2)
- construction noise sources for the Proposal (as listed in Table 15).

Noise emissions from the construction sites have been modelled using an implementation of the ISO 9613 propagation algorithm with neutral metrological conditions.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures would also vary as the construction equipment moves around the site.

5.4 Construction noise assessment

Construction noise levels at the identified residential and non-residential receivers have been assessed against the standard hours, out-of-hours daytime and evening and out-of-hours night-time NMLs (as shown in Table 7 and Table 8). However, the level of impact may change depending on the final construction methodology which would be developed by the contractor, and further assessment would be undertaken if required.

During construction not all equipment would be operating simultaneously at all times and in the one location (as assumed in the modelling), which would result in a reduction in predicted noise levels.

Mitigation measures for receivers have been specified in Section 5.8 which would reduce the impact of these exceedances.

Noise results are presented in Appendix C as noise contour layers over aerial maps.

5.4.1 Noise impacts at residences during standard working hours

The predicted construction noise levels at residential receivers during standard hours are shown in Table 16. All receivers within approximately 200 metres of the Proposal are anticipated to experience construction noise levels in exceedance of the NMLs during standard hours for the majority of construction stages (with the exception of stage 4B (refresh of Platform Building).

The most affected receivers would be the nearest residential receivers located along Victoria Street and Charles Street to the south, Waller Street to the north and Myra Street to the east (R1 to R7). Only two residences (R32 and R33) are expected to experience construction noise levels below the relevant NML for all construction stages.

The highest noise levels would likely occur during stage 1B (removal of vegetation) due to the operation of the mulcher across the entire site. Residential receivers R1 to R7 are predicted to be 'highly affected', experiencing noise levels higher than the 75 dB(A) threshold, and all residential receivers (with the exception of R32 and R33) are predicted to experience noise levels higher than the relevant NMLs. However, while this stage of construction would generate a significant noise source,

the duration of operation of the mulching equipment is likely to be limited and the resulting impacts, though high, will be short-term and confined to during the day (standard hours) only.

It is noted that, as described above, the final construction methodology may show that this equipment is not ultimately to be used across the entire site (e.g. only on Waller Street, north of the station), in which case the predicted construction noise levels at locations further from this equipment may correspondingly reduce.

Stages 3A (platform modifications) and 3B (construction of lift shafts) are also predicted to generate significant noise levels, due predominantly to works associated with demolishing and reinstating / replacing concrete structures. Residential receivers R1 to R4 and R6 to R7 are predicted to be 'highly affected', experiencing noise levels higher than the 75 dB(A) threshold, and all residential receivers (with the exception of R18, R20, R31, R32 and R35) are predicted to experience noise levels higher than the relevant NMLs.

Stage 5B (interchange works) is also predicted to generate high noise levels with two receivers, R3 and R6 predicted to be 'highly affected' due to station based works, and one receiver (R10) predicted to be 'highly affected' due to trenching work taking place directly in front of the property along Lindesay Street. Underboring of the cable conduits would be considered during detailed design to minimise noise (and property access) impacts. Exceedances of NMLS are predicted at the majority of residential receivers, due predominantly to the operation of the coring machine. However, while this is a significant noise source, the duration of operation of this equipment is likely to be limited and the resulting impacts, though high, will be short-term and day-time (standard hours) only.

Table 16 Predicted noise impacts at representative residential receivers – Standard hours

ID	Distance (metres)	NML	1A	1B	1C	2A	2B	3A	3B	4A	4B	5A	5B
R1	27	46	**75**	**>85**	70	72	74	**82**	**83**	**78**	66	69	72
R2	55	46	67	**82**	62	68	70	**75**	**76**	73	61	65	68
R3	32	53	**75**	**>85**	70	**80**	**82**	**>85**	**>85**	**85**	73	**75**	**78**
R4	29	46	73	**>85**	68	68	70	**75**	**76**	**70**	58	62	65
R5	104	46	63	**78**	58	64	66	72	73	70	58	63	66
R6	38	53	**75**	**>85**	**70**	73	**75**	**81**	**82**	**77**	65	**80**	**85**
R7	37	46	**75**	**>85**	**70**	67	69	**75**	**76**	71	59	67	70
R8	132	53	57	72	52	52	54	59	60	57	45	50	53
R9	130	53	55	70	50	56	58	64	65	58	46	57	60
R10	113	53	64	**79**	59	63	65	70	71	68	56	64	**>85**
R11	152	46	56	71	51	58	60	65	66	61	49	57	60
R12	157	53	59	74	54	61	63	68	69	66	54	63	71
R13	265	46	52	67	47	54	56	61	62	60	48	54	57
R14	251	46	53	68	48	53	55	60	61	58	46	53	56
R15	215	46	56	71	51	55	57	63	64	61	49	58	61
R16	207	46	52	67	47	50	52	57	58	55	43	51	59
R17	262	53	53	68	48	52	54	62	63	57	45	58	61
R18	263	53	48	63	43	42	44	49	50	47	35	41	44
R19	289	46	46	61	41	48	50	55	56	53	41	49	52
R20	329	53	44	59	39	43	45	50	51	45	33	40	51
R21	367	46	45	60	40	47	49	54	55	53	41	49	53
R22	344	46	49	64	44	51	53	58	59	57	45	52	55
R23	339	53	49	64	44	50	52	58	59	54	42	52	55
R24	371	53	50	65	45	51	53	59	60	57	45	54	57
R25	421	53	46	61	41	48	50	55	56	47	35	43	46

ID	Distance (metres)	NML	1A	1B	1C	2A	2B	3A	3B	4A	4B	5A	5B
R26	410	53	49	64	44	51	53	58	59	51	39	53	56
R27	454	46	44	59	39	46	48	53	54	50	38	41	44
R28	425	46	46	61	41	46	48	54	55	52	40	49	52
R29	611	46	45	60	40	47	49	54	55	51	39	47	50
R30	548	46	46	61	41	47	49	54	55	52	40	49	52
R31	615	46	44	59	39	46	48	53	54	49	37	45	48
R32	574	53	37	52	32	39	41	46	47	45	33	41	43
R33	610	53	38	53	33	37	39	45	46	36	24	39	43
R34	690	46	41	56	36	37	39	49	50	41	29	45	48
R35	694	46	40	55	35	34	36	41	42	39	27	35	38
R36	729	46	38	53	33	42	44	49	50	48	36	45	48

Notes:

- Items highlighted in grey indicate predicted noise impact at this receiver during this work stage is above NML.
- Items in **BOLD RED** indicate a 'highly affected' residential receiver with a level of 75 dB(A) or higher.

5.4.2 Noise impacts at residences during out of hours works

The predicted construction noise levels at residential receivers during out of hours works are shown in:

- Table 17 for representative residential receivers during day and evening out of hours works
- Table 18 for representative receivers during night-time out of hours works.

Construction stages 1C, 2A, 2B, 3A, 3B and 4B are expected to include some out of hours works and would generally be undertaken during 48 hour rail shutdowns. As such they have been included in Table 17 and Table 18. While some works during stage 1C (services relocations) would be required out of hours, these works would not include noisy activities (during out of hours).

The results of the modelling show exceedances of the out of hours NMLs (daytime, evening and night time) at residential receivers during all assessed stages of construction.

Receivers R1 and R2 (Victoria Street to the south), R3 and R4 (Waller Street to the north and Myra Street to the east) and R6 and R7 (Victoria Street and Porter Avenue to the south) are anticipated to experience noise levels above the 75 dB(A) threshold for evening and night time works during stages 3A (platform modifications) and 3B (construction of lift shafts). Receiver R3 (Waller Street to the north) is also expected to exceed this threshold during stages 2A (platform stabilisation).

All residential receivers (with the exception of R32 and R33) are anticipated to experience out of hours (day and evening) construction noise levels exceeding the relevant NMLs during stages 3A (platform modifications) and 3B (construction of lift shafts).

Table 17 Predicted noise impacts at representative residential receivers – Out of hours (day and evening)

ID	Distance (metres)	NML	1C	2A	2B	3A	3B	4B
R1	27	41	70	72	74	**82**	**83**	66
R2	55	41	62	68	70	**75**	**76**	61
R3	32	48	70	**80**	**82**	**>85**	**>85**	73
R4	29	41	68	68	70	**75**	**76**	58
R5	104	41	58	64	66	72	73	58
R6	38	48	70	73	**75**	**81**	**82**	65
R7	37	41	70	67	69	**75**	**76**	59
R8	132	48	52	52	54	59	60	45

ID	Distance (metres)	NML	1C	2A	2B	3A	3B	4B
R9	130	48	50	56	58	64	65	46
R10	113	48	59	63	65	70	71	56
R11	152	41	51	58	60	65	66	49
R12	157	48	54	61	63	68	69	54
R13	265	41	47	54	56	61	62	48
R14	251	41	48	53	55	60	61	46
R15	215	41	51	55	57	63	64	49
R16	207	41	47	50	52	57	58	43
R17	262	48	48	52	54	62	63	45
R18	263	48	43	42	44	49	50	35
R19	289	41	41	48	50	55	56	41
R20	329	48	39	43	45	50	51	33
R21	367	41	40	47	49	54	55	41
R22	344	41	44	51	53	58	59	45
R23	339	48	44	50	52	58	59	42
R24	371	48	45	51	53	59	60	45
R25	421	48	41	48	50	55	56	35
R26	410	48	44	51	53	58	59	39
R27	454	41	39	46	48	53	54	38
R28	425	41	41	46	48	54	55	40
R29	611	41	40	47	49	54	55	39
R30	548	41	41	47	49	54	55	40
R31	615	41	39	46	48	53	54	37
R32	574	48	<35	39	41	46	47	<35
R33	610	48	<35	37	39	45	46	<35
R34	690	41	36	37	39	49	50	<35
R35	694	41	35	<35	36	41	42	<35
R36	729	41	<35	42	44	49	50	36

Notes:

– Items highlighted in grey indicate predicted noise impact at this receiver during this work stage is above NML.

– Items in **BOLD RED** indicate a 'highly affected' residential receiver with a level of 75 dB(A) or higher.

Table 18 Predicted noise impacts at representative residential receivers – Out of hours (night)

ID	Distance (metres)	NML	1C	2A	2B	3A	3B	4B
R1	27	41	70	72	74	**82**	**83**	66
R2	55	41	62	68	70	**75**	**76**	61
R3	32	44	70	**80**	**82**	**>85**	**>85**	73
R4	29	41	68	68	70	**75**	**76**	58
R5	104	41	58	64	66	72	73	58
R6	38	44	70	73	**75**	**81**	**82**	65
R7	37	41	70	67	69	**75**	**76**	59
R8	132	44	52	52	54	59	60	45
R9	130	44	50	56	58	64	65	46

ID	Distance (metres)	NML	1C	2A	2B	3A	3B	4B
R10	113	44	59	63	65	70	71	56
R11	152	41	51	58	60	65	66	49
R12	157	44	54	61	63	68	69	54
R13	265	41	47	54	56	61	62	48
R14	251	41	48	53	55	60	61	46
R15	215	41	51	55	57	63	64	49
R16	207	41	47	50	52	57	58	43
R17	262	44	48	52	54	62	63	45
R18	263	44	43	42	44	49	50	35
R19	289	41	41	48	50	55	56	41
R20	329	44	39	43	45	50	51	<35
R21	367	41	40	47	49	54	55	41
R22	344	41	44	51	53	58	59	45
R23	339	44	44	50	52	58	59	42
R24	371	44	45	51	53	59	60	45
R25	421	44	41	48	50	55	56	35
R26	410	44	44	51	53	58	59	39
R27	454	41	39	46	48	53	54	38
R28	425	41	41	46	48	54	55	40
R29	611	41	40	47	49	54	55	39
R30	548	41	41	47	49	54	55	40
R31	615	41	39	46	48	53	54	37
R32	574	44	<35	39	41	46	47	<35
R33	610	44	<35	37	39	45	46	<35
R34	690	41	36	37	39	49	50	<35
R35	694	41	35	34	36	41	42	<35
R36	729	41	<35	42	44	49	50	36

Notes:

- Items highlighted in grey indicate predicted noise impact at this receiver during this work stage is above NML.
- Items in **BOLD RED** indicate a 'highly affected' residential receiver with a level of 75 dB(A) or higher.

5.4.3 Noise impacts at non-residential receivers

Since non-residential receivers' NMLs are fixed values for all periods of the day and not based on RBLs, one assessment for non-residential receiver operating hours is presented as shown in Table 19.

Receiver N1 (Lifehouse Church) is anticipated to be the most affected, due to its proximity to the proposed western construction compound associated with the Proposal. At this location, estimated noise levels from all construction stages are anticipated to be higher than the 55 dB(A) NML. However, this is based on the assumption that all identified construction activities will occur within the adjacent construction compound. This is likely a conservative estimate, as the actual activities occurring in the compound are unlikely to include all items of equipment required for the Proposal (such as a mulcher for vegetation removal).

The highest noise levels would likely occur during stage 1B (removal of vegetation) due to the operation of the mulcher. Receiver N1 is predicted to be the only 'highly affected', experiencing noise levels higher than the 75 dB(A) threshold, with the majority of other non-residential receivers predicted to experience noise levels higher than the relevant daytime NMLs. However, while this is a significant noise source, the duration of operation of the mulching equipment is likely to be limited and the

resulting impacts, though high, would be short-term and confined to during the day (standard hours) only.

Stages 3A (platform modifications) and 3B (construction of lift shafts) are also predicted to generate significant noise levels, due predominantly to works associated with demolishing and reinstating / replacing concrete structures. The majority of non-residential receivers are predicted to experience noise levels higher than the relevant NMLs.

Receivers N13 (an industrial property), N14 (Kindy Patch Emmas), N15 (St Joseph's Primary School), N17 (St Joseph's East Maitland Church) and N19 (Maitland East Public School) are not expected to experience construction noise levels above the relevant NML during any stage of construction.

Table 19 Predicted noise impacts at representative non-residential receivers – Standard hours

ID	Distance (metres)	NML	1A	1B	1C	2A	2B	3A	3B	4A	4B	5A	5B
N1	4	55	75	90	70	77	79	84	85	80	68	69	72
N2	127	70	57	72	52	59	61	66	67	60	48	56	59
N3	147	55	57	72	52	57	59	64	65	61	49	55	58
N4	170	55	53	68	48	55	57	62	63	58	46	54	57
N5	218	55	54	69	49	55	57	62	63	59	47	53	56
N6	225	55	49	64	44	48	50	56	57	54	42	49	52
N7	231	55	50	65	45	52	54	59	60	54	42	51	54
N8	239	55	51	66	46	51	53	58	59	54	42	51	54
N9	299	55	51	66	46	53	55	60	61	58	46	53	56
N10	305	55	40	55	35	42	44	49	50	47	35	42	45
N11	507	55	50	65	45	52	54	59	60	57	45	53	56
N12	462	55	39	54	34	41	43	48	49	45	33	41	44
N13	429	75	49	64	44	50	52	58	59	55	43	53	56
N14	547	55	<35	46	<35	<35	<35	39	40	37	<35	<35	37
N15	583	55	37	52	<35	35	37	46	47	39	<35	36	39
N16	591	55	45	60	40	39	41	46	47	45	<35	42	45
N17	653	55	<35	48	<35	35	37	42	43	40	<35	36	39
N18	613	55	47	62	42	46	48	54	55	52	40	49	52
N19	747	55	<35	49	<35	36	38	43	44	39	<35	38	41

Notes:

– Items highlighted in grey indicate predicted noise impact at this receiver during this work stage is above NML.

5.5 Sleep disturbance assessment

As there are several construction stages which are proposed to incorporate some out of hours works, consideration must also be given to the potential for sleep disturbance to residential receivers during potential night works.

The awakening reaction criterion of 60 to 65 dB(A) is predicted to be exceeded at residences during all stages scheduled to take place during the night-time period; Stages 1C, 2A, 2B, 3A, 3B and 4B. These properties include R1 to R17 and are located within a distance of approximately 265 metres of the Proposal. For residential receivers R1 to R7, it is likely that night works may generate instances in which both the screening level is exceeded, and awakening events may occur. For work packages 3A and 3B, these events may also occur in residences as far from the Proposal as residence R15.

These results are based on the predicted night time L_{Aeq} dB(A) construction noise levels presented in Table 18. It should be noted that $L_{A1(1\ minute)}$ noise levels associated with any item of equipment may be higher than the L_{Aeq} dB(A) levels and therefore Table 8 represents the likely minimum situation in which sleep disturbance may occur.

As identified previously, up to six weekend rail shutdowns may be required. Therefore, although the out of hours construction works are anticipated to be of high acoustic impact to potentially-affected residential receivers, the duration of such works would be limited and short-term.

5.6 Construction traffic assessment

Noise from construction traffic on public roads is not covered by the ICNG. However, the additional short-term increase in local traffic from construction vehicles, in particular as construction traffic is frequently a higher percentage of heavy vehicles than the normal situation, is acknowledged as having the potential to cause disturbance to affected receivers. Hence, there is a valid requirement to assess the potential impact of this additional construction traffic against ECRTN guidelines.

No traffic counts have been conducted for this assessment however numbers of construction heavy vehicles have been estimated by TfNSW as approximately one to 12 vehicles per day Monday to Friday. For rail shutdown works, there would be in the order of five to 20 vehicles per day.

From on-site observations during the deployment of unattended noise measurement equipment, the existing traffic flow is substantially greater than the proposed construction traffic numbers. Therefore, the construction vehicles would have a negligible impact on existing road traffic noise in the area. The traffic generated by the Proposal is considered to comply with the *Road Noise Policy* criteria.

To minimise noise impacts from construction traffic, construction traffic should be considered as part of the construction noise and vibration management plan.

5.7 Construction vibration assessment

Vibration-intensive works may include the use of the following items of equipment:

- bored piling
- excavator
- jackhammer
- mini excavator
- vibration plate.

The safe working distances of these items of equipment from off-site receivers are shown in Table 20 which are based on recommendations of the CNS). If these safe working distances are complied with, no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage.

Based on the indicative construction activities assessed for the Proposal, there is some potential that works would occur within the safe working distances for off-site receivers. If vibration-intensive works are required within these safe working distances, mitigation measures to control excessive vibration would be implemented as outlined in Section 5.8.

The heritage structures of Victoria Street Station have been assessed for the potential to sustain cosmetic damage from the proposed construction works. Table 20 presents indicative safe working distances for the most significant vibration generating plant.

The safe working distances for cosmetic damage are generally considered to be conservative and working within them would not necessarily result in damage. However as factors such as work practices and intervening structures can affect vibration levels, vibration monitoring is recommended within these distances and should be undertaken at the beginning of vibration intensive works in order to refine the safe working distances for site specific conditions. Supplementary vibration monitoring is outlined in Section 5.8.

Table 20 Safe working distances of vibration intensive equipment to be used during the Proposal

Plant	Rating/ Description	Cosmetic damage – residential/commercial	Cosmetic damage - heritage	Human response

13 tonne excavator	As per 900kg hydraulic hammer	7 m (nominal)	12 m (nominal)	23 m
Bored piling	≤ 800 mm	2 m (nominal)	2 m (nominal)	2 m (nominal)
Jack hammer	Hand held	1 m (nominal)	1 m (nominal)	Avoid contact with structure
Mini excavator	As per 300kg hydraulic hammer	2 m (nominal)	4 m (nominal)	7 m
Vibration plate[1]	As per jackhammer	1 m (nominal)	1 m (nominal)	Avoid contact with structure

Notes:
1. There are no recommendations provided in the CNS for a vibration plate; the data on which the vibration level is assumed is given in the Rating/Description column.

There are no residential receivers for which the cosmetic damage or human response safe working distances are encroached by proposed construction activities for the Proposal.

The Lifehouse Church lies within the recommended safe working distances for human response and cosmetic damage from vibration from the 13 tonne excavator. However, as the area adjacent to the church would be used as a construction compound; no excavation would be undertaken within this area. This area may be used to store the excavator. Therefore the potential for cosmetic damage is considered negligible.

The Proposal would be undertaken in the very close vicinity of the heritage listed Platform Building, with excavation works likely to be required within the safe working distances of this structure. The Platform Building may also be at risk from indirect impacts during construction. This impact would be managed via the implementation of mitigation measures outlined in Section 5.8 including supplementary vibration monitoring.

In terms of human response, residential receivers R1 to R4, R6 and R7 also fall within the 23 metre safe working distance, as does the Lifehouse Church (N1). Therefore it is likely that vibration from the construction equipment may be felt and observed at the residences and the church, although the potential for structural damage to residential buildings is very low.

Piling is also proposed during stages 3A and 3B. However, as given the piling method is bored piling (rather than impact piling), vibration generated by this process is very low, and is not expected to cause cosmetic damage or human response issues for any receivers within proximity of the Proposal (other than potentially the Platform Building). As outlined in section 5.8, it is recommended that attended vibration measurements are undertaken when piling commences to determine site-specific safe working distances and that a permanent vibration monitoring system is installed prior to the commencement of piling work.

5.8 Construction mitigation measures

5.8.1 Construction Noise and Vibration Management Plan

A Construction Noise and Vibration Management Plan (CNVMP) should be developed for the Proposal and implemented prior to commencement of construction activities. The CNVMP should include all reasonable and feasible safeguards to manage the noise emissions from the site and manage any complaints which may occur due to construction noise. The CNVMP should include, as a minimum, the following:

- identification of nearby residences and other sensitive land uses
- description of approved hours of work

- description and identification of all construction activities, including work areas, equipment and duration
- description of work practices (generic and specific) which would be applied to minimise noise and vibration
- a complaints handling process
- noise and vibration monitoring procedures
- overview of community consultation required for identified high impact works.

Construction works should be planned and carried out during standard construction hours wherever possible. For works which are required to be undertaken out of hours (during rail shutdowns) activities that generate the highest noise levels should be minimised as far as is possible, and confined to the earlier portions of the evening and night-time periods as far as is practical to minimise the risk of sleep disturbance throughout the night.

Table 21 presents the standard mitigation measures contained within the CNS which should be considered as mitigation measures as part of the CNVMP.

Table 21 TfNSW's Construction Noise Strategy standard mitigation measures

Action required	Safeguard details
Management measures	
Implement any project specific mitigation measures required	In addition to the measures set out in this table, any project specific mitigation measures identified in this report.
Implement community consultation measures	Periodic notification (monthly letterbox drop or equivalent), website, Project Infoline, Construction Response Line, email distribution list. This shall include non-residential receivers which are predicted to exceed NMLs.
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Noise monitoring	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Source controls	
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.

Action required	Safeguard details
Construction respite period	High noise and vibration generating activities may only be carried out in continuous blocks, not exceeding three hours each, with a minimum respite period of one hour between each block. Sensitive periods for non-residential receivers, such as schools, shall be identified during community consultation. Examples of sensitive periods include exam periods or ceremonies. Where possible work during these periods should be minimised or avoided.
Equipment selection	Use quieter and less vibration emitting construction methods where feasible and reasonable.
Maximum noise levels	The noise levels of plant and equipment must have operating sound power or sound pressure levels that would meet the predicted noise levels.
Rental plant and equipment	Noise emissions should be considered as part of the selection process.
Use and siting of plant	Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Plant and vehicles to be turned off when not in use. Noise-emitting plant to be directed away from sensitive receivers.
Plan works site and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction related traffic	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.

Action required	Safeguard details
Silencers on mobile plant	Where possible reduce noise from mobile plant through additional fittings including residential grade mufflers, damped hammers such as “City” Model Rammer Hammers and air Parking brake engagement is silenced.
Path controls	
Shield stationary noise sources such as pumps, compressors, fans etc.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

In addition to the standard mitigation measures identified in the CNS, the following specific mitigation measures have been developed as a result of the predicted impacts associated with the Proposal:

- details of any necessary out-of-hours work required and processes to obtain approval from TfNSW should form part of the CNVMP
- noisy work has been scheduled to be undertaken during the standard construction hours. Noisy activities that cannot be undertaken during standard construction hours should be scheduled as early as possible during the evening and / or night-time periods. Where out-of-hours works is required, an out-of-hours works application form must be submitted to TfNSW for approval on a case-by-case basis
- consideration should be given to providing construction respite periods to mitigate construction noise impacts to the receivers which have been identified as being ‘highly noise affected’
- alternative works methods, such as use of hydraulic or electric-controlled units in place of diesel units, and/or the use of alternative plant which performs the same function (e.g. rubber wheeled instead of steel tracked plant) should be considered and implemented where feasible and reasonable
- during the installation of high voltage cabling, the cable conduits would be underbored where possible, rather than being installed via open trenches to minimise noise (and property access) impacts
- equipment should be regularly inspected and maintained to ensure it is in good working order
- truck drivers should be advised of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (e.g. minimising the use of engine brakes, and no extended periods of engine idling). Construction sites should be arranged to limit the need for reversing associated with regular / repeatable movements (e.g. trucks transporting spoil) to minimise the use of reversing alarms. Where feasible and reasonable, non-tonal reversing alarms should be used, taking into account the requirements of the Workplace Health and Safety legislation
- the noise monitoring program should be implemented to assist in confirming and controlling the site-specific potential for disturbance at particularly sensitive localities at the commencement of activities and periodically during the construction program as the works progress. The results should be reviewed to determine if additional mitigation measures are required. All measurements should be undertaken in accordance with Australian Standard *1055.1-1997 – Acoustics – Description and measurement of environmental noise, Part 1: General procedures.*

For vibration-intensive activities which occur within the safe working distance for cosmetic damage for the Lifehouse Church and the Victoria Street Station Platform Building, as presented in Table 20, management methods to mitigate these impacts should include, as a minimum, the following:

- the use of less vibration-intensive methods of construction or equipment is preferred where possible to reduce annoyance and potential for cosmetic damage. All equipment should be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts
- works scheduling to effectively manage construction vibration impacts. Wherever possible, vibration intensive works should be limited to the least sensitive times of the day. Coordination with the Lifehouse Church may be required to determine those periods when the church building is proposed to be in use, in order to schedule vibration-intensive activities outside of these times
- respite periods should be negotiated with the Lifehouse Church for construction activities expected to generate high levels of vibration
- vibration measurements are undertaken when work commences, to determine site-specific safe working distances. Vibration intensive work should not proceed within the safe working distances unless a permanent vibration monitoring system is installed approximately one metre from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are approaching the peak particle velocity objective. It is also advisable to carry out dilapidation surveys of sensitive heritage structures before construction works begins
- for vibration-intensive work scheduled to occur near a building, within the safe working distance for human response but outside the safe working distance for cosmetic damage, it is considered that the additional measures highlighted in Section 5.8.3 would be sufficient to mitigate the vibration impact at nearby receivers. Therefore vibration monitoring would not be required at these properties.

5.8.2 Community consultation and complaints handling

All residents and sensitive receivers impacted by noise and vibration from the proposed works which are expected to exceed the NML should be consulted about the Proposal prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works.

The information provided to the residents / building occupants should include:

- programmed times and locations of construction work
- the hours of proposed works
- construction noise and vibration impact predictions
- construction noise and vibration mitigation measures being implemented on site.

Community consultation regarding construction noise and vibration should be detailed in a Community Liaison Plan for the construction of the Proposal and should include a 24 hour hotline and complaints management process.

5.8.3 TfNSW's *Construction Noise Strategy* - Additional mitigation measures

Where exceedances in airborne noise are still expected to occur after standard mitigation measures have been applied, TfNSW's *Construction Noise Strategy* (CNS) recommends the implementation of additional mitigation measures. These mitigation measures are specified within TfNSW's CNS and presented in Table 22.

The provision of additional mitigation is based on the predicted exceedances above RBLs and when the exceedances occur. The RBLs can be found in Table 7.

Table 22 Additional mitigation measures matrix for airborne construction noise

Time period		Action level[1,2]			
		0 – 10 dB(A) Noticeable	10 – 20 dB(A) Clearly audible	20 – 30 dB(A) Moderately intrusive	>30 dB(A) Highly intrusive
Standard	Mon-Fri (7am-6pm)	-	-	LB, M	LB, M
	Sat (8am-1pm)				
	Sun/Pub Hol (Nil)				
OOHW[3] Period 1	Mon-Fri (6pm-10pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN, RO[2]
	Sat (7-8am) & (1pm-10pm)				
	Sun/Pub Hol (8am-6pm)				
OOHW[3] Period 2	Mon-Fri (10pm-7am)	LB	M, LB, RO[2]	M, IB, LB PC, SN, RO[2]	AA, M, IB, LB, PC, SN, RO
	Sat (10pm-8am)				
	Sun/Pub Hol (6pm-7am)				

Notes:

1. Action level is $L_{Aeq(15\ minute)}$ noise level above background (RBL) - qualitative assessment of noise levels
2. The following abbreviations have been used (refer to Table 23 for further details):
   AA: Alternative accommodation
   M: Monitoring
   IB: Individual briefings
   LB: Letterbox drops
   RO: Proposal specific respite offer
   PC: Phone calls
   SN: Specific notifications.
3. OOH – Outside of standard hours

Table 23 outlines the additional mitigation measures, as outlined in the CNS.

Table 23 Description of additional mitigation measures

Abbreviation	Mitigation measure	Explanation
LB	Letter Box Drops	All residences should be notified as a minimum by letterbox drop seven days ahead of construction activities.
M	Monitoring	Attended noise monitoring is to be undertaken as follows: At the commencement of out-of-hours works (within the first two nights), where out-of-hours works activities change; and Noise measurements shall be undertaken in accordance with the procedure documented in AS1055.1-1997 Acoustics - Description and Measurement of Environmental Noise - General Procedures.
IB	Individual Briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that would be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
RO	Project Specific Respite Offer	Residents subjected to lengthy periods of noise or vibration may be eligible for a project specific respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. The offer could comprise pre-purchased movie tickets or similar offer. This measure is determined on a project-by-project basis.

PC	Phone Calls	Phone calls detailing relevant information would be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific Notifications	Specific notifications are letterbox dropped or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise management levels. This form of communication is used to support periodic notifications, or to advertise unscheduled works.
AA	Alternative Accommodation	Alternative accommodation options should be provided for residents living in close proximity to construction works that are likely to incur noise levels significantly above the applicable level.

6.0 Operational noise

With the exception of the proposed reconfiguration, the operation of the station will remain unchanged as a result of the Proposal. There will be no additional patrons, and no expected change in the frequency or capacity of passenger trains servicing the station.

During the operation of the Proposal, there may be minor changes to the existing noise levels due to the provision of a new accessible parking space, kiss and ride area and taxi rank on the northern side of the station on Waller Street, however this is not considered to produce significant noise emissions. Additional operational equipment at the station would include three new lifts and a 315 kVA kiosk transformer located on the corner of Waller Street / Victoria Street (north) intersection which would not produce significant noise emissions.

As such, the operational noise environment is expected to remain largely unchanged. Standard noise controls such as appropriate selection of mechanical plant (such as lifts) would reduce any impacts.

If required, operational noise emissions shall be addressed during the detailed design phase in order to comply with Sydney Trains speech intelligibility requirements and operational noise criteria as per the *Industrial Noise Policy.* Operational noise criteria are presented in Section 4.0.

7.0 Conclusions

A construction and operational noise and vibration impact assessment has been completed for the Victoria Street Station Upgrade (the 'Proposal'). Nearby noise and vibration sensitive receivers were identified and unattended noise measurements were completed to characterise the existing noise environment. The measured noise levels were used to establish operational and construction noise management levels.

7.1 Construction activity noise

Construction scenarios have been developed in consultation with TfNSW and the proposed equipment has been detailed within this report. Five distinct work packages comprising twelve construction work activities were used in a computer-based noise model to determine the potential changes to noise levels. Construction noise impacts were then assessed at 36 representative residential receivers which were selected to assess the noise impacts within areas with likely similar background noise levels. Impacts were also assessed at representative nearby non-residential sensitive receivers, including the Lifehouse Church immediately adjacent to the Proposal and the heritage listed Victoria Street Platform Building, but also including medical centres, educational facilities (Maitland High School, King Street Community Pre School), child care centres, other places of worship, and commercial and industrial receivers.

All receivers within approximately 200 metres of the Proposal are anticipated to experience construction noise levels in exceedance of the relevant standard hours NMLs for the majority of construction scenarios.

The most affected receivers would be the nearest residential receivers R1 to R7 (Victoria Street and Charles Street to the south, Waller Street to the north and Myra Street to the east), as well as the non-residential receiver N1 (Lifehouse Church).

Only two residences (R32 and R33) are expected to experience construction noise levels below the relevant NML for all construction stages.

The highest noise levels would likely occur during stages 1B, 3A, 3B and 5B. Residential receivers R1 to R7 and R10 are predicted to be 'highly affected', experiencing noise levels higher than the 75 dB(A) threshold, and all residential receivers (with the exception of R32 and R33) are predicted to experience noise levels higher than the relevant NMLs.

For proposed out of hours works, receivers R1 and R2 (Victoria Street to the south), R3 and R4 (Waller Street to the north and Myra Street to the east) and R6 and R7 (Victoria Street and Porter Avenue to the south) are anticipated to experience noise levels above the 75 dB(A) threshold for evening and night time works in stages 3A and 3B associated with platform and lift shaft works. Receiver R3 (Waller Street to the north) is also expected to exceed this threshold for works associated with stages 2A and 2B during anchor installation for platform stabilisation works.

All residential receivers (with the exception of R32 and R33) are anticipated to experience out of hours evening construction noise levels exceeding the relevant NMLs during stages 3A and 3B.

Implementation of mitigation measures described would aim to minimise and manage noise impacts where reasonable and feasible.

Mitigation measures have been recommended in line with TfNSW's *Construction Noise Strategy* in order to minimise and manage the impact of construction noise on nearby noise sensitive receivers.

7.2 Construction vibration

Safe working distances to nearby structures have been recommended for nominated plant. If the safe working distances are maintained then no adverse impact from the vibration intensive works are likely in terms of human response or cosmetic damage. Should vibration intensive activities within the safe working distances be required, the additional mitigation measures provided would be implemented.

Based on the indicative construction activities assessed for the Proposal, it is likely that works would occur within the safe working distances for the Lifehouse Church and the Victoria Street Station (a heritage listed item).

Vibration monitoring is recommended for works which occur within the safe working distances.

7.3 Operation

During the operation of the Proposal, there may be minor changes to the existing noise levels due to the provision of a new accessible parking space, kiss and ride area and taxi rank on the northern side of the station on Waller Street, however this is not considered to result in a significant increase in noise generation. Similarly, the addition of three new lifts and a 315 kVA kiosk transformer would not produce significant noise emissions As such, the operational noise environment is expected to remain largely unchanged. If required, operational noise emissions shall be addressed during the detailed design phase in order to comply with Sydney Trains speech intelligibility requirements and operational noise criteria as per the *Industrial Noise Policy.*

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Decibel [dB]	The measurement unit of sound.
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows: 0dB(A) - Threshold of human hearing 30dB(A) - A quiet country park 40dB(A) - Whisper in a library 50dB(A) - Open office space 70dB(A) - Inside a car on a freeway 80dB(A) - Outboard motor 90dB(A) - Heavy truck pass-by 100dB(A) - Jackhammer/Subway train 110dB(A) - Rock Concert 115dB(A) - Limit of sound permitted in industry 120dB(A) - 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.

L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW *Industrial Noise Policy* and the EPA's *Road Noise Policy*.

Appendix B

Noise Logging

Appendix B Noise Logging

NL1 – 59 Lindesay Street, East Maitland – 3/03/16 – 10/03/16

Logger Type: Cirrus 171

Serial No: G061710

Address: 59 Lindesay Street, East Maitland

Location: Front garden

Facade / Free Field: Free Field

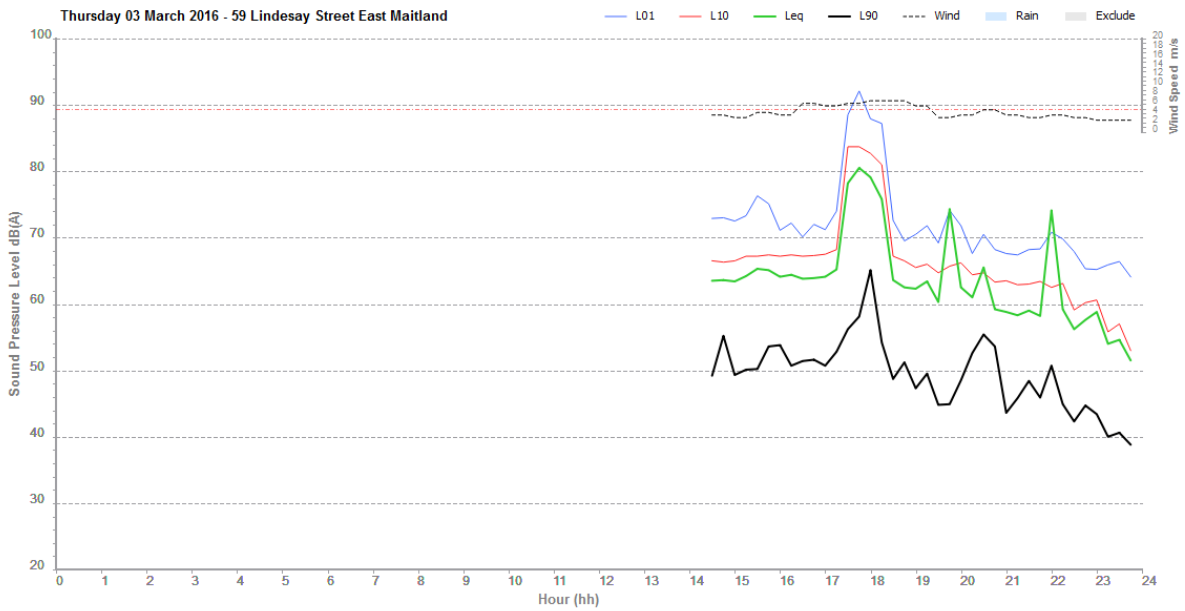
Environment: Mix of natural sounds and some local traffic.

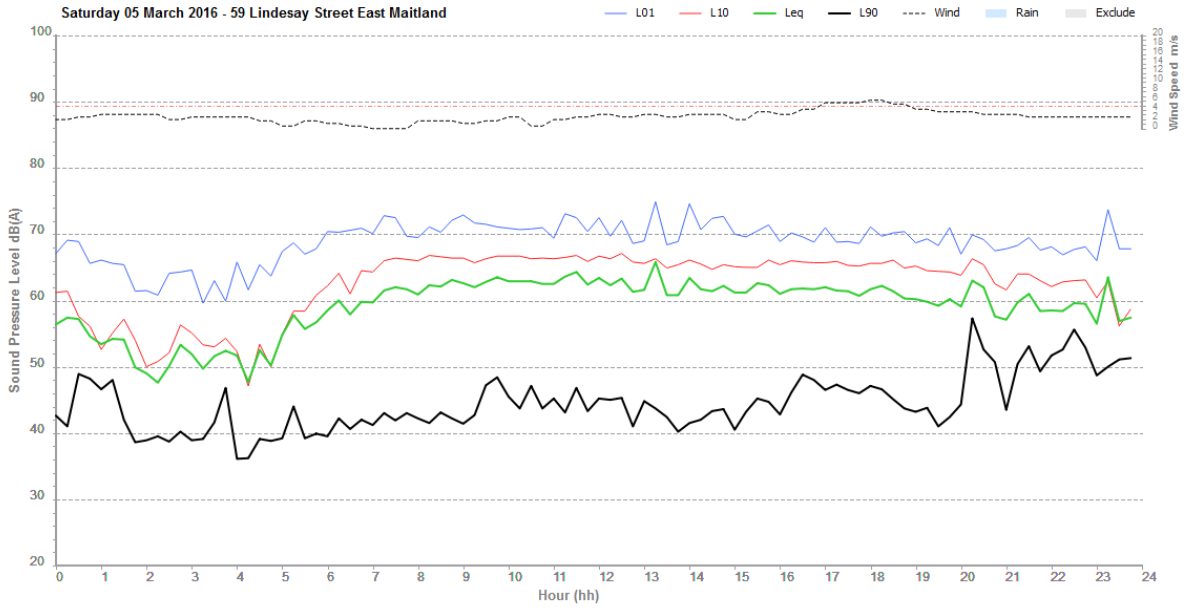
Table 24 Measured noise levels – NL1

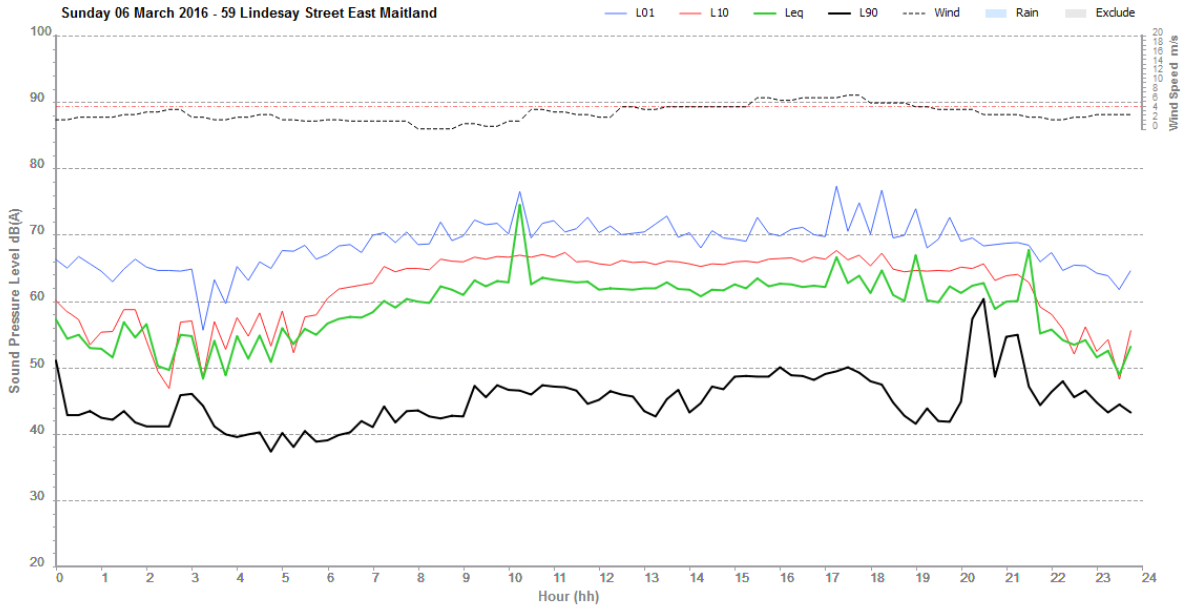
INP noise level, dB(A)		
Period	**Log average L_{Aeq}**	**Rating Background Level**
Day	64	43
Evening	62	43
Night	58	39

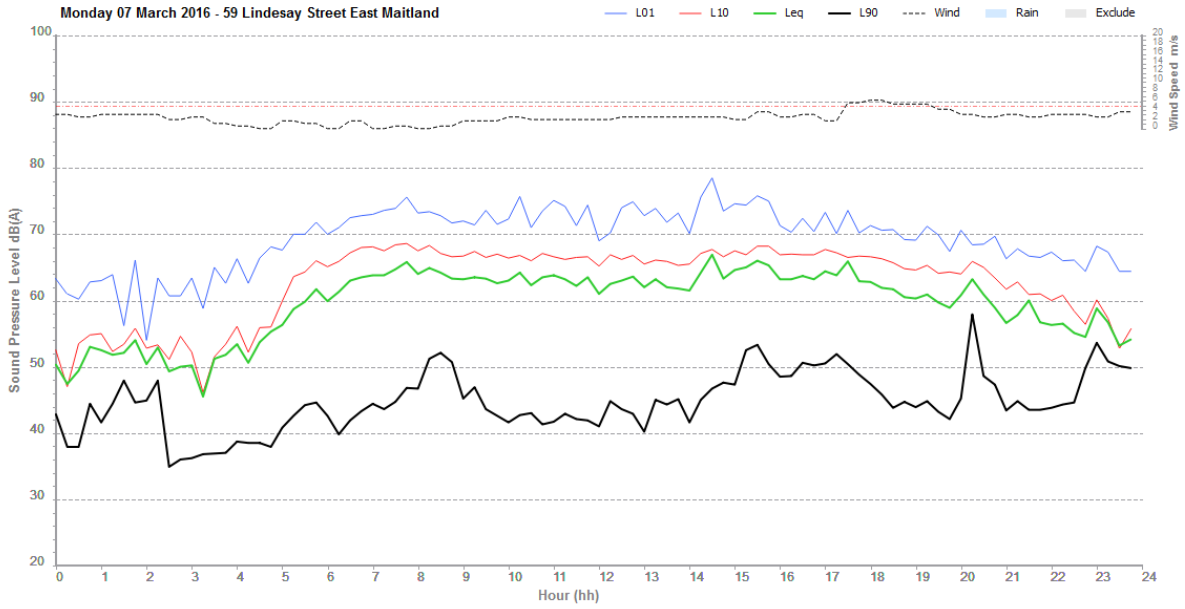
Figure 3 Logger 1 location photo

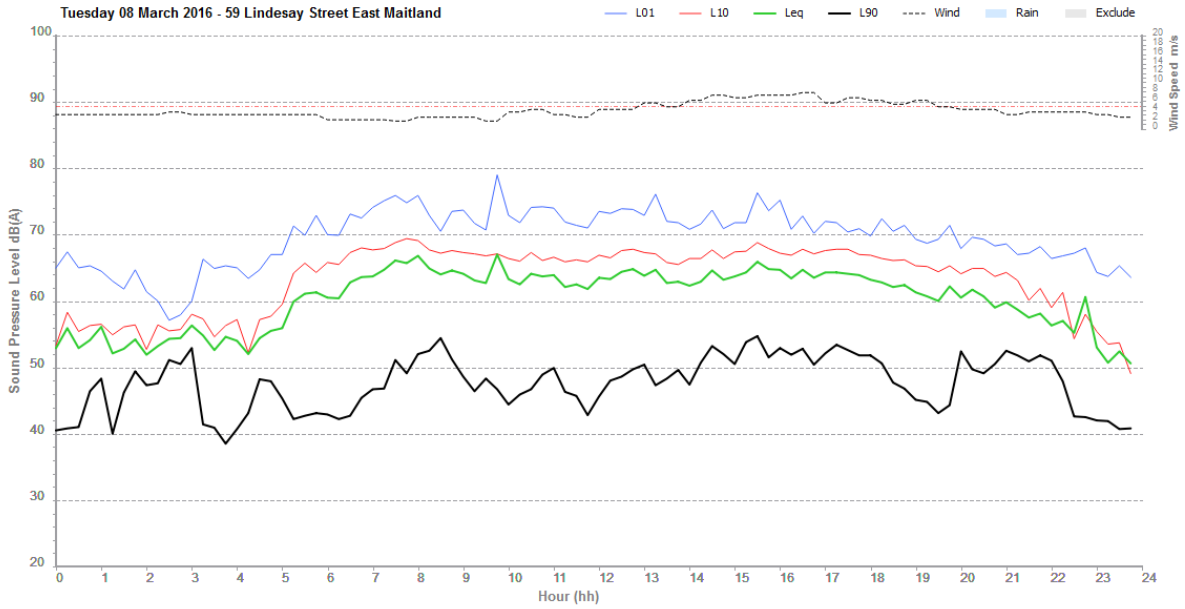
Logger graphs

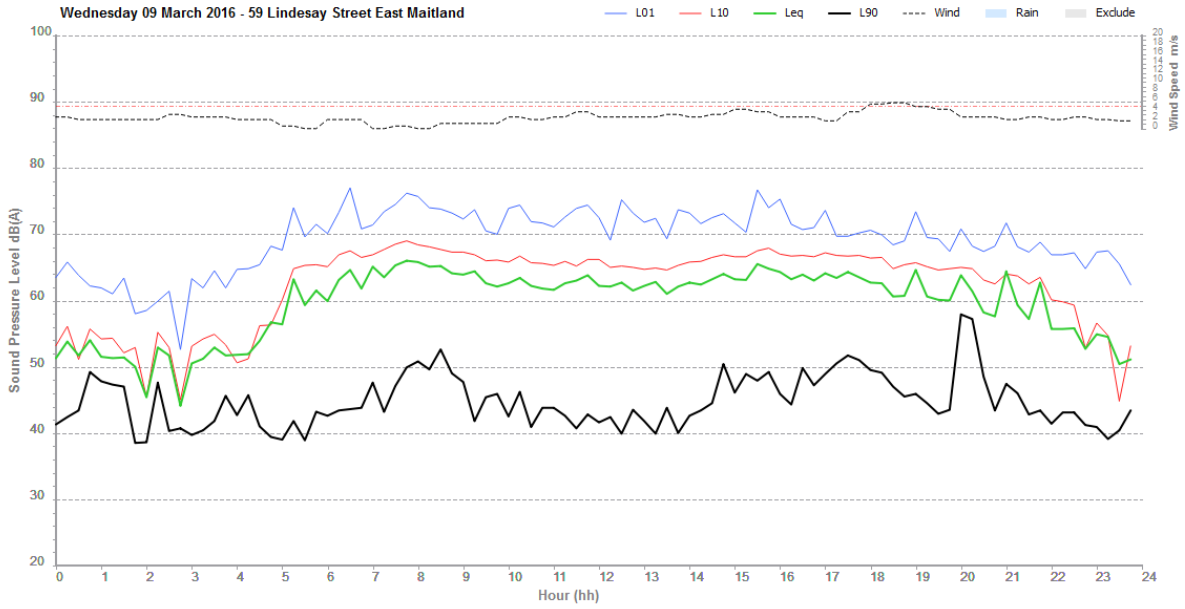



Saturday 05 March 2016 - 59 Lindesay Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Sunday 06 March 2016 - 59 Lindesay Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Monday 07 March 2016 - 59 Lindesay Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Tuesday 08 March 2016 - 59 Lindesay Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Wednesday 09 March 2016 - 59 Lindesay Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Thursday 10 March 2016 - 59 Lindesay Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)

NL2 – 3 Charles Street, East Maitland – 3/03/16 – 11/03/16

Logger Type: Rion NL52

Serial No: 164395

Address: 3 Charles Street, East Maitland

Location: Front garden

Facade / Free Field: Free Field

Environment: Mix of natural sounds and some local traffic' vehicle noise on Victoria Street dominates.

Table 25 Measured noise levels – NL2

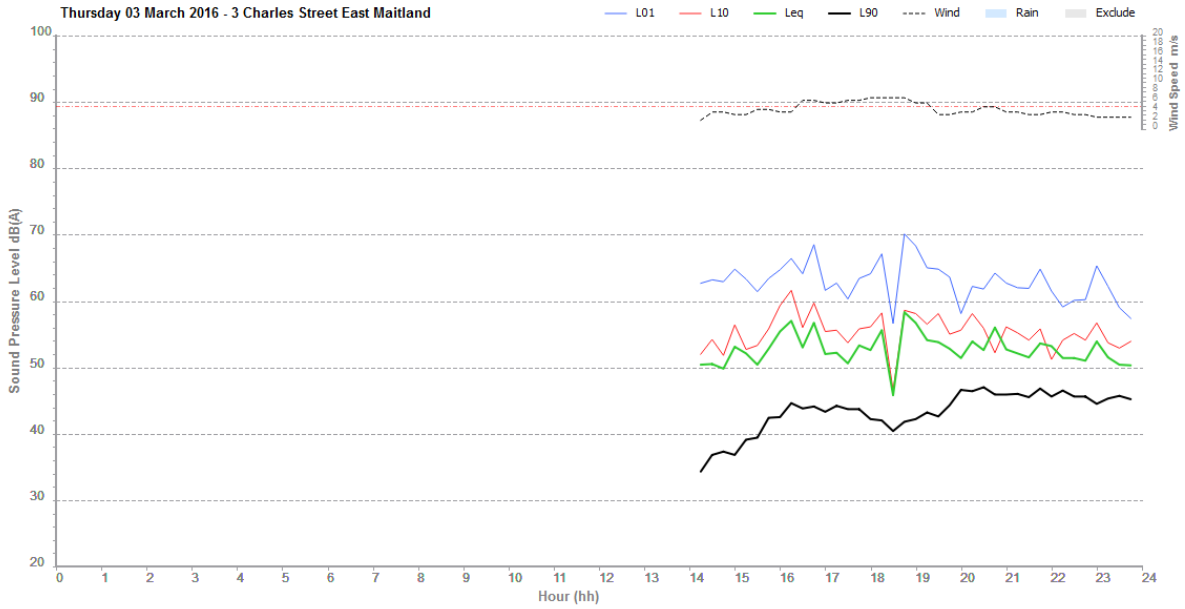
INP noise level, dB(A)		
Period	**Log average**	**Rating Background Level**
Day	54	36
Evening	54	36 (41)[1]
Night	52	36

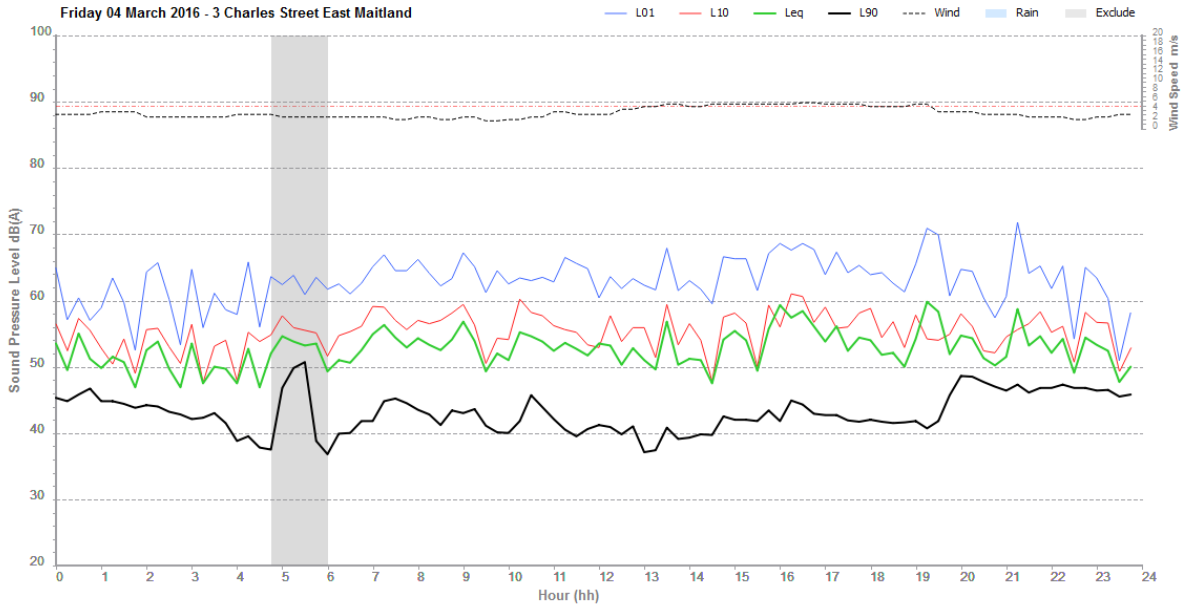
Note:

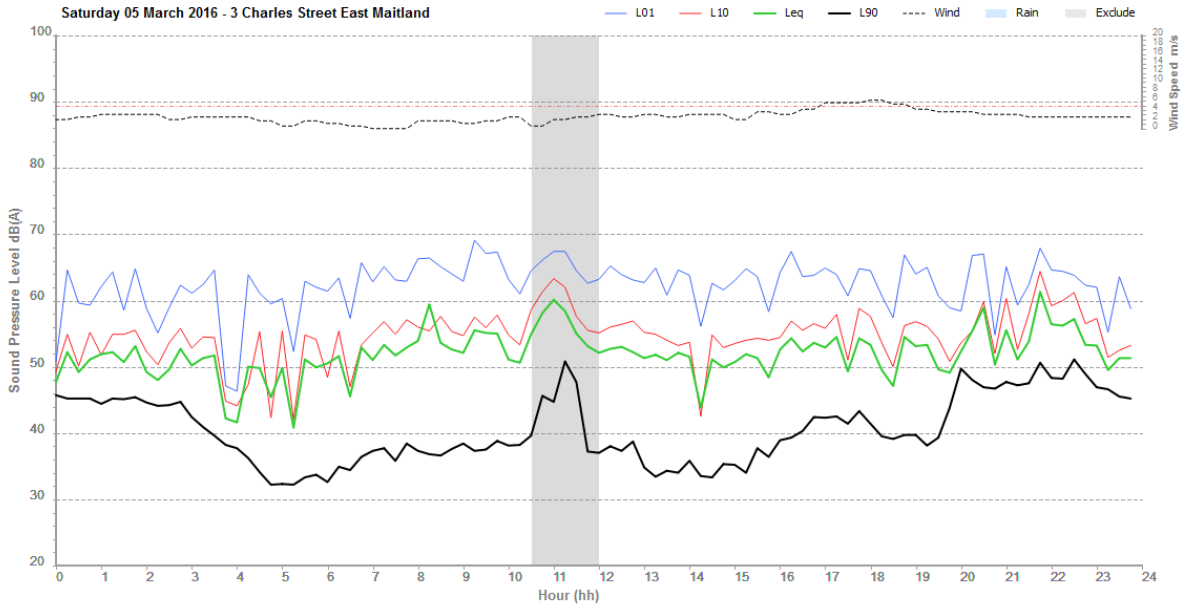
1. Level adjusted to the daytime RBL in accordance with the INP.

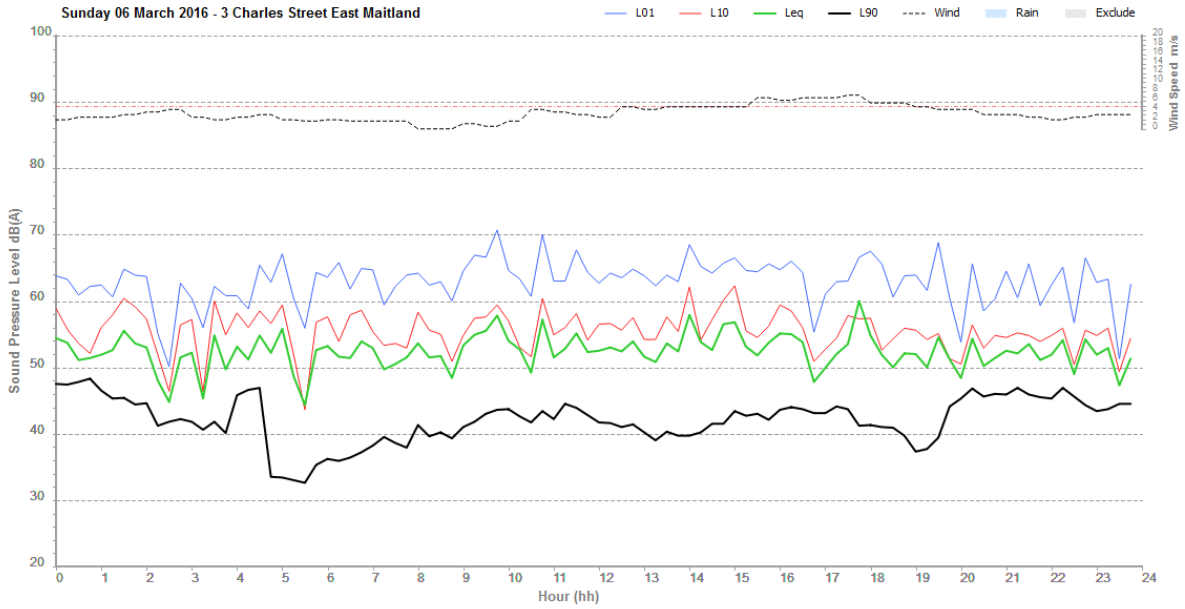
Figure 4 Logger 2 location photo

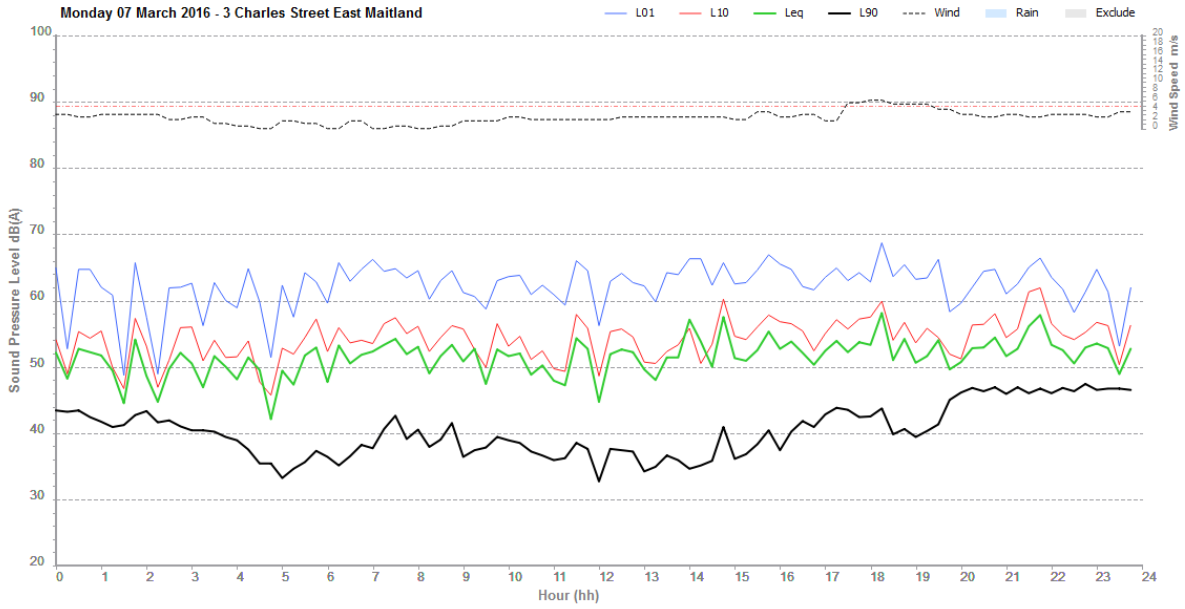
Logger graphs

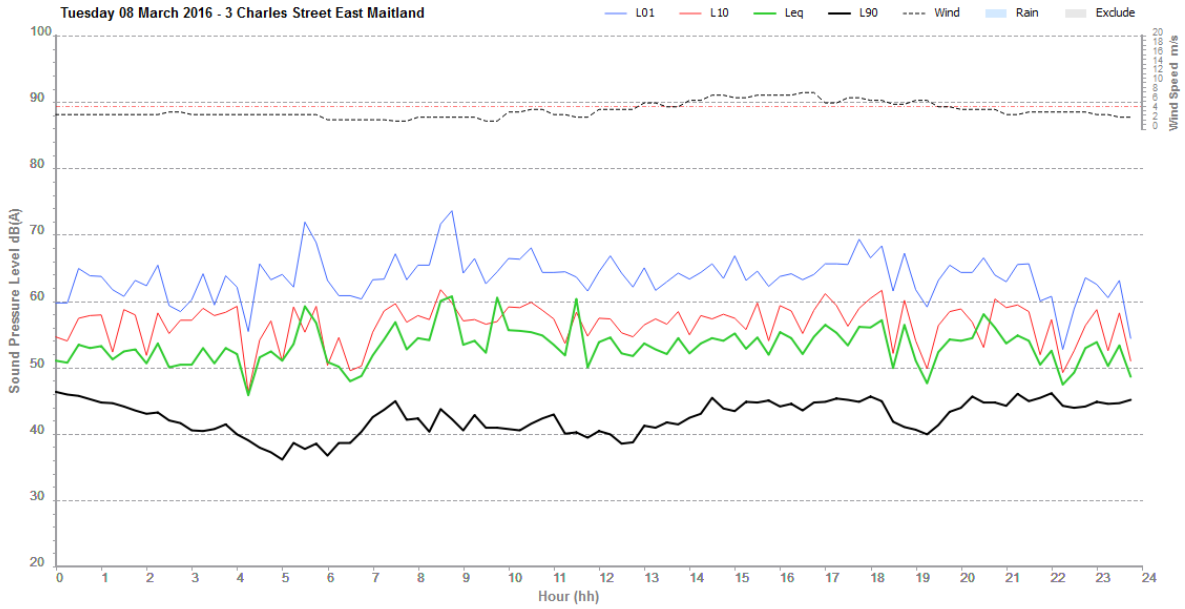


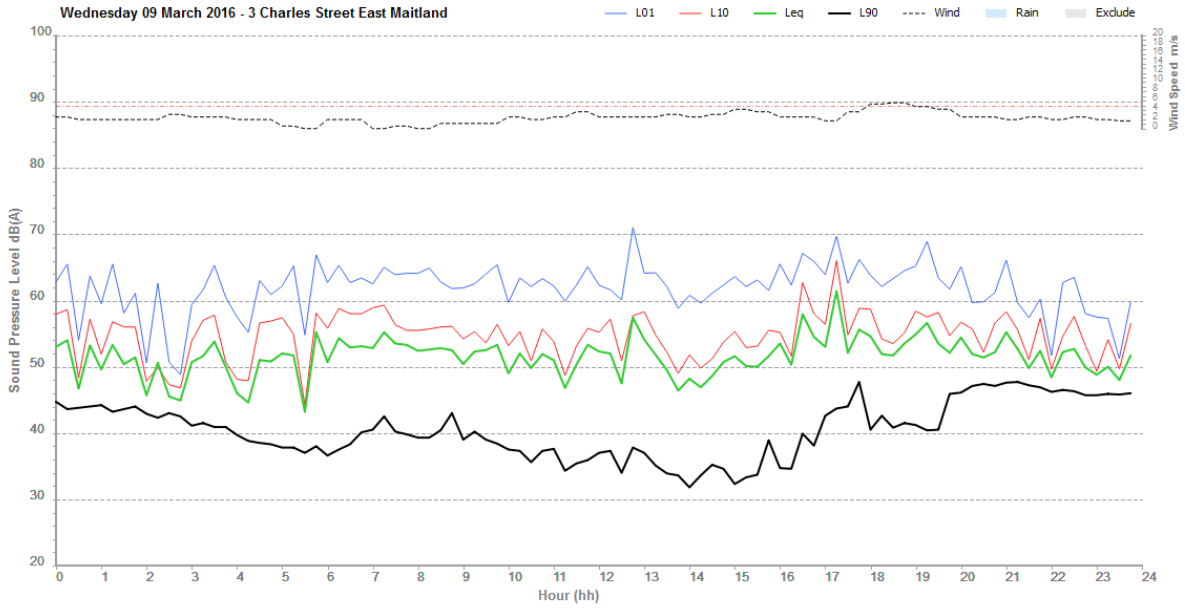


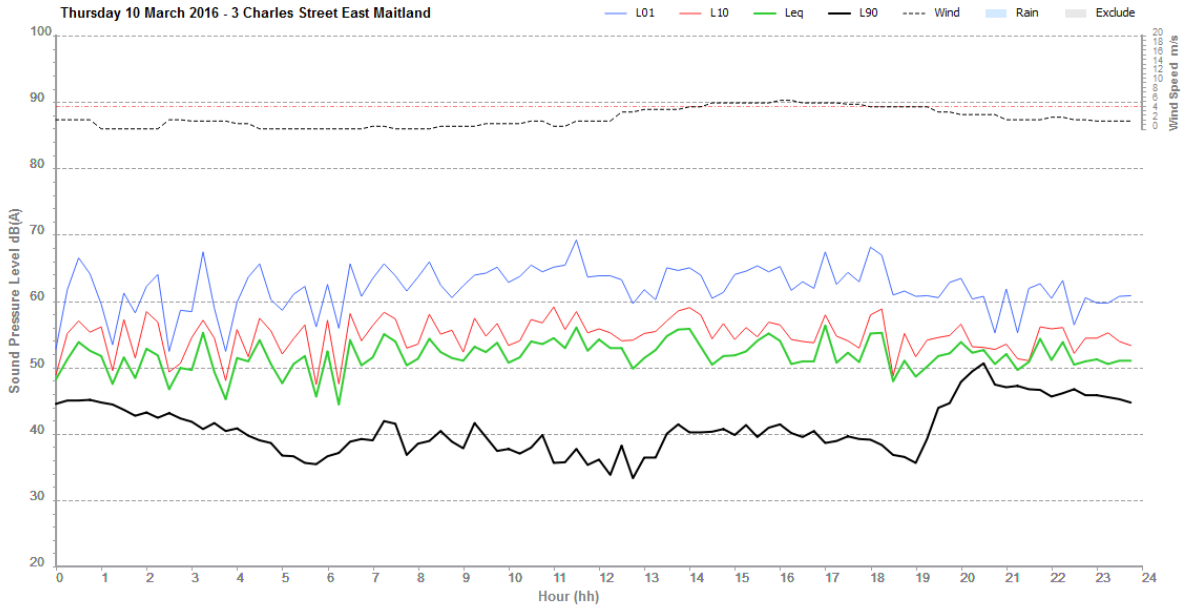

Saturday 05 March 2016 - 3 Charles Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)

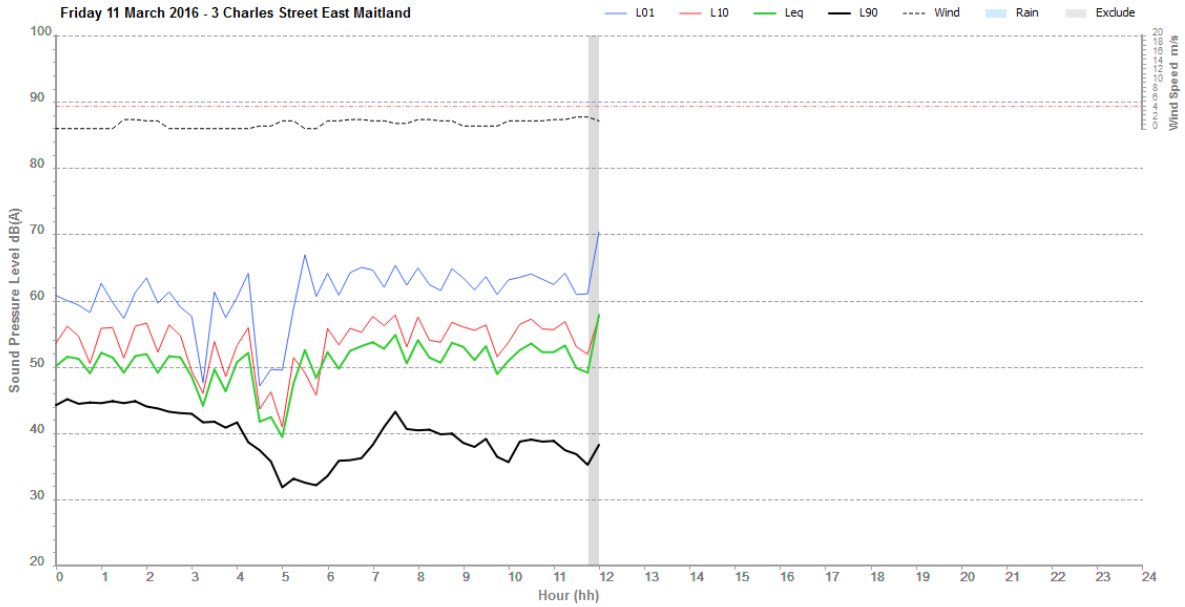

Sunday 06 March 2016 - 3 Charles Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Monday 07 March 2016 - 3 Charles Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Tuesday 08 March 2016 - 3 Charles Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)

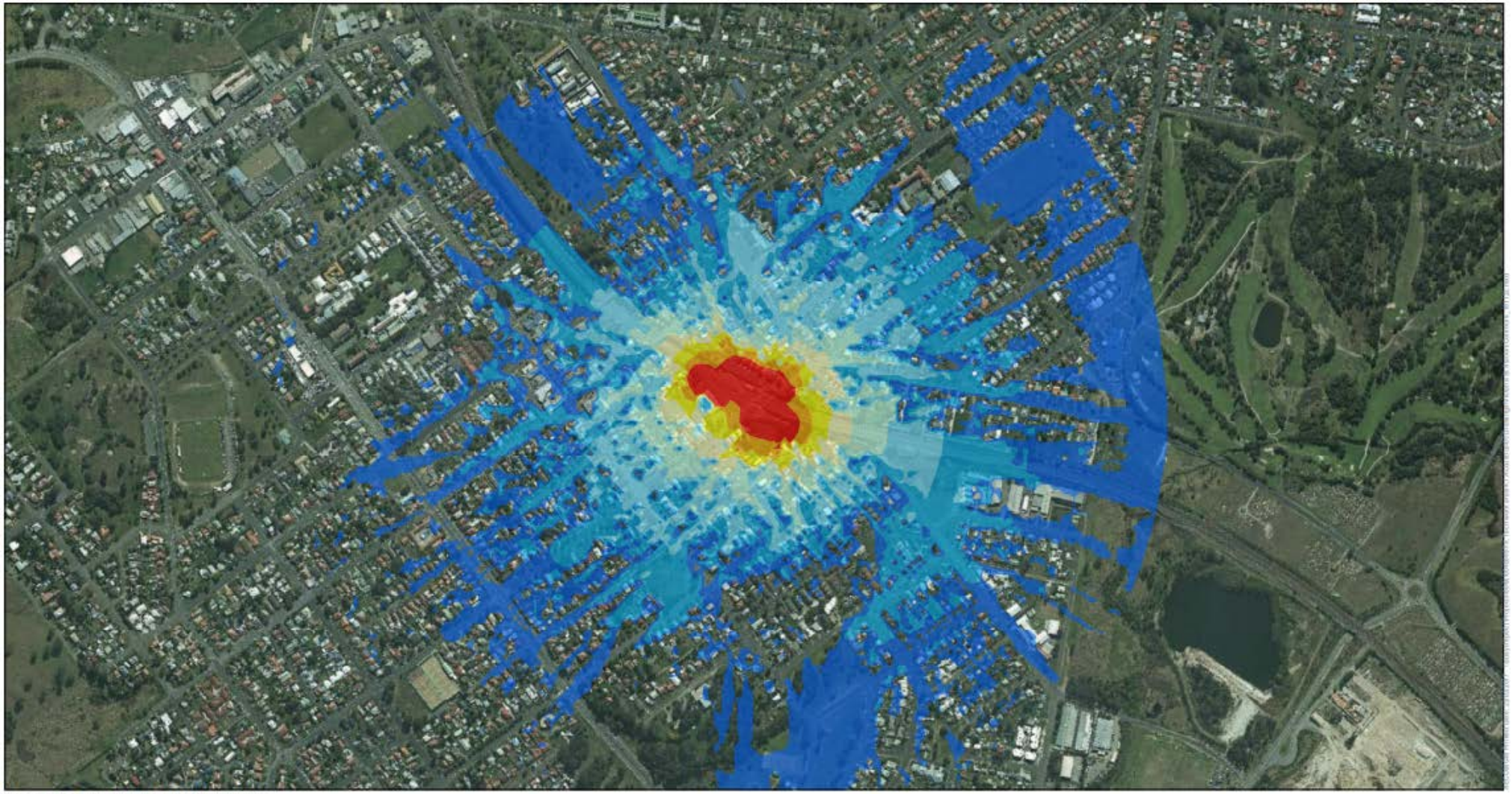

Wednesday 09 March 2016 - 3 Charles Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Thursday 10 March 2016 - 3 Charles Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)


Friday 11 March 2016 - 3 Charles Street East Maitland
L01
L10
Leq
L90
Wind
Rain
Exclude
Sound Pressure Level dB(A)
Wind Speed m/s
Hour (hh)

Appendix C

Predicted Noise Contours - Construction



VICTORIA STREET CAR PARK UPGRADE

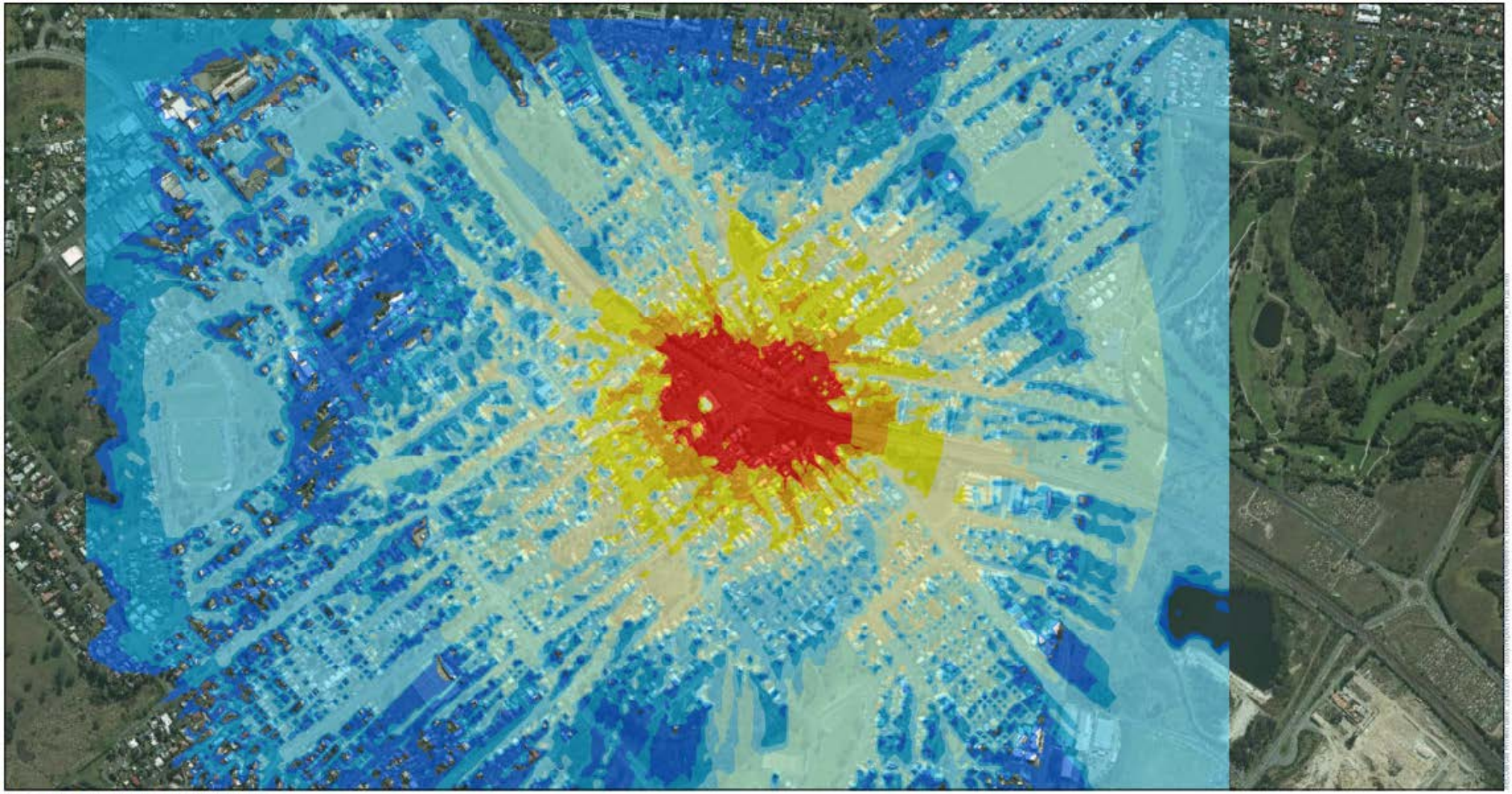
Sub Stage 1A - Establishment of site compound

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75



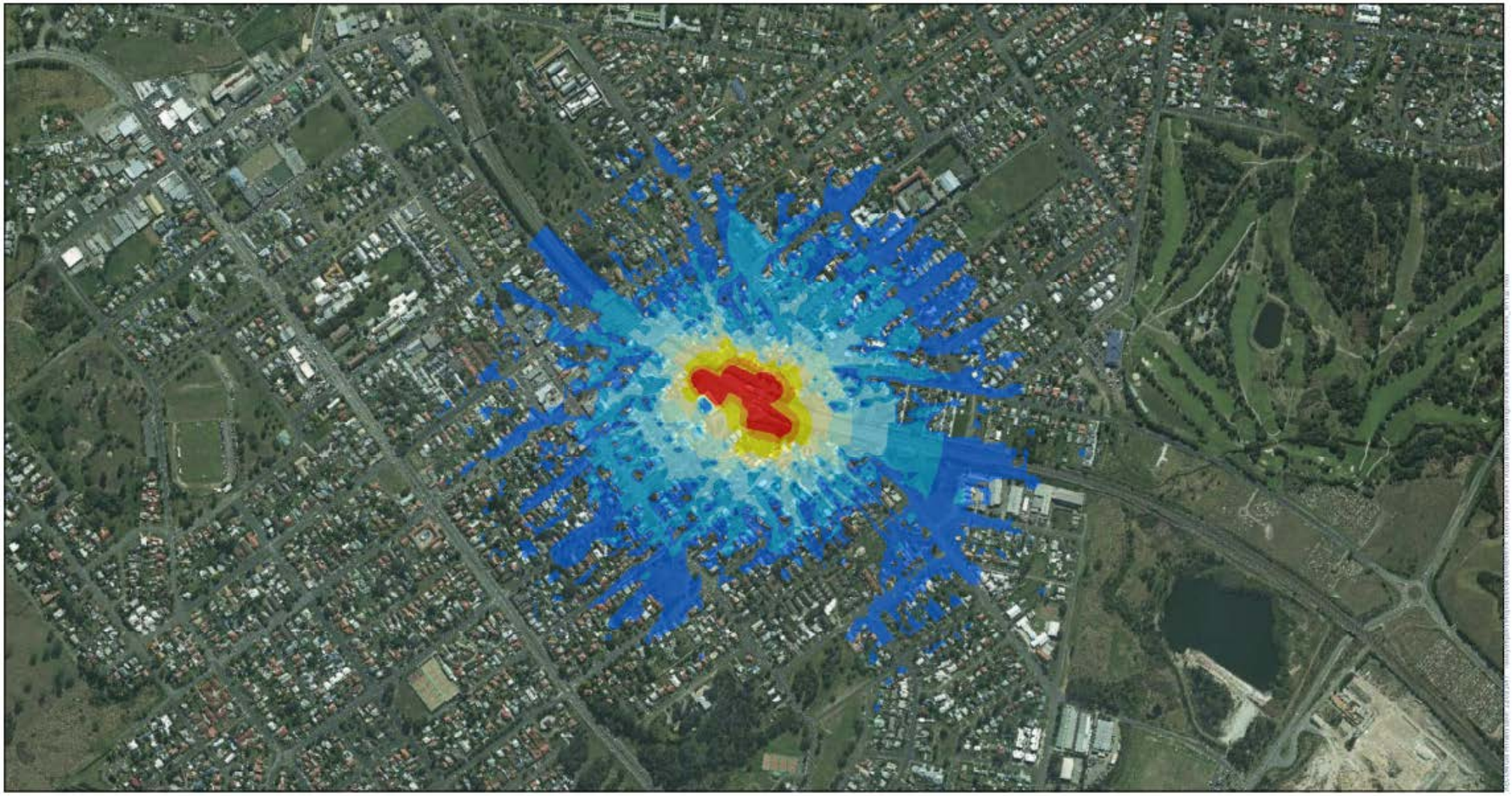
VICTORIA STREET CAR PARK UPGRADE

Sub Stage 1B - Removal of vegetation to allow for new lifts/stairs

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)



VICTORIA STREET CAR PARK UPGRADE

Sub Stage 1C - Services relocation

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75

VICTORIA STREET CAR PARK UPGRADE

Sub Stage 2B - Installation of horizontal anchors

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75

VICTORIA STREET CAR PARK UPGRADE

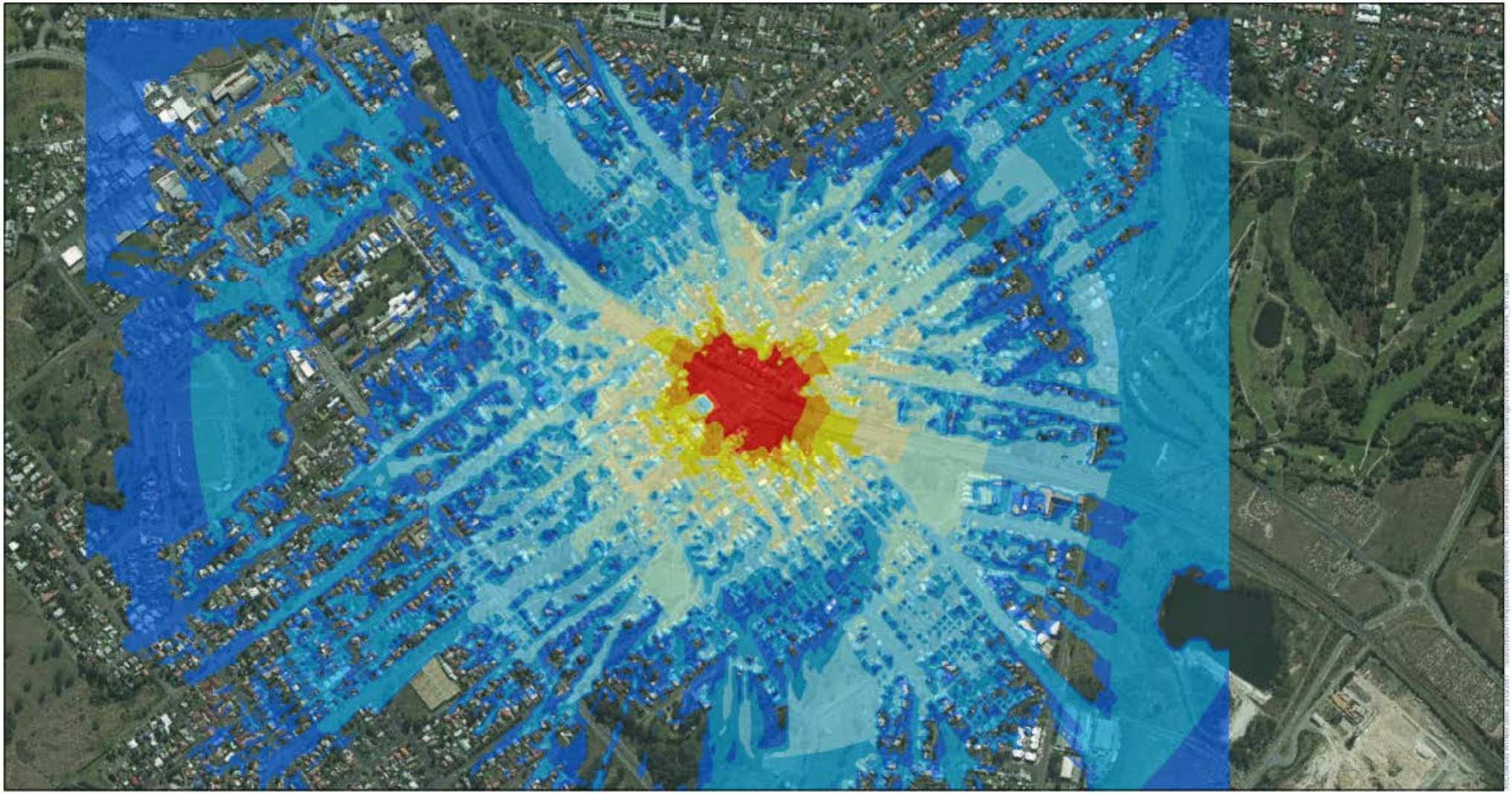
Sub Stage 2C - Installation of inclined anchors

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75



VICTORIA STREET CAR PARK UPGRADE

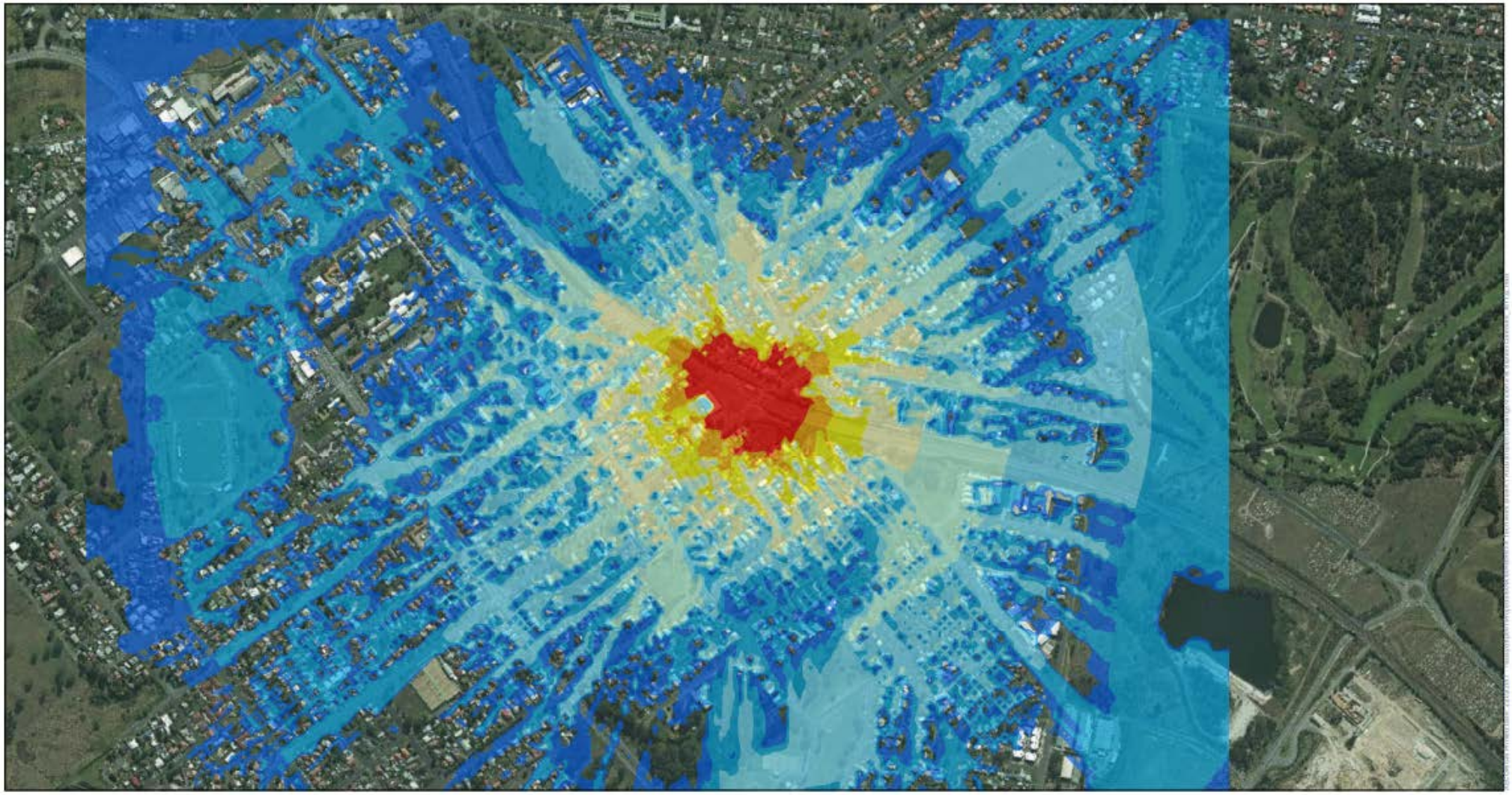
Sub Stage 3A - Platform modifications, lift shaft installation

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75



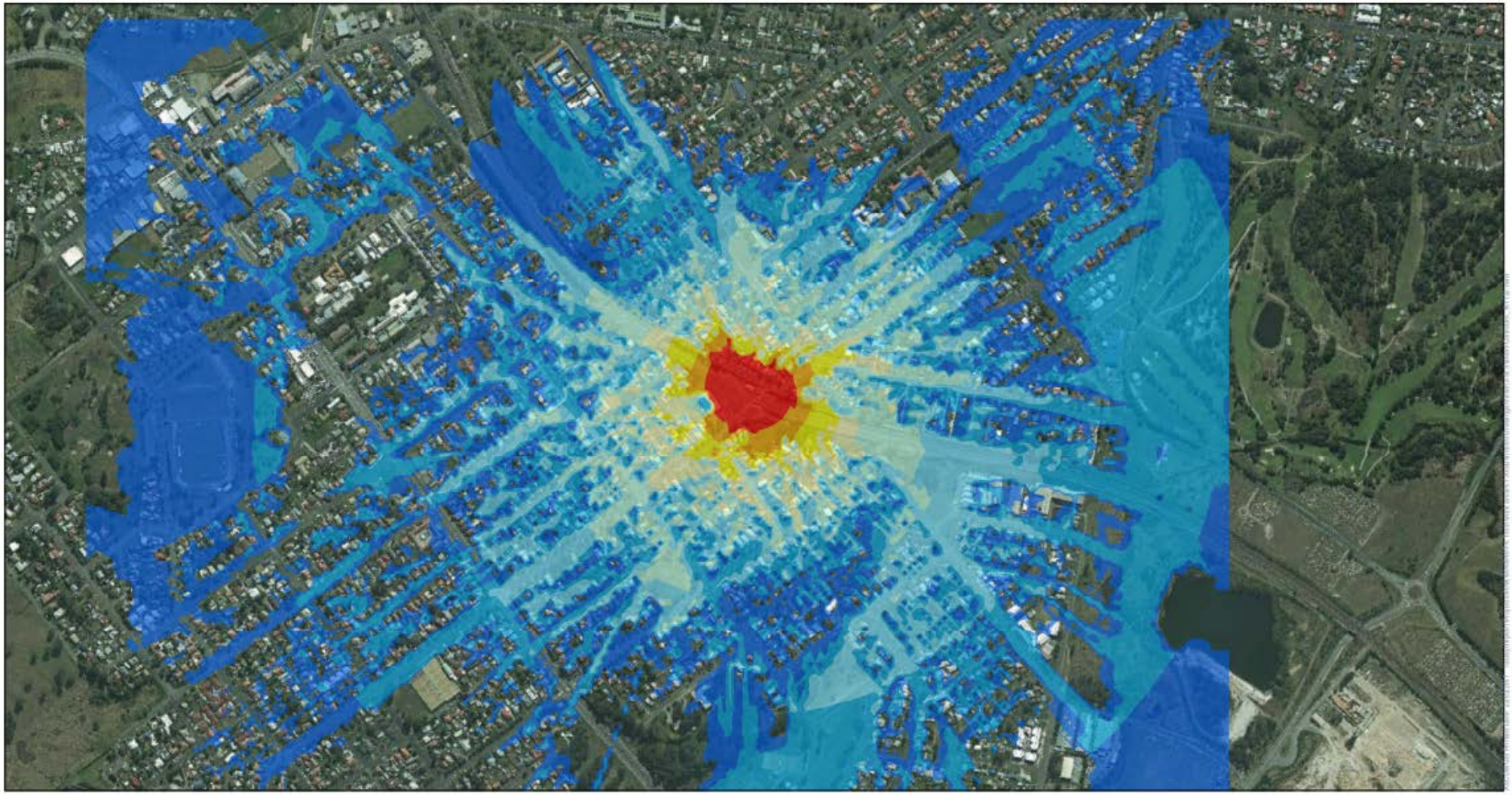
VICTORIA STREET CAR PARK UPGRADE

Sub Stage 3B - Construction of lift shaft, stairs, fencing and new canopies

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)



VICTORIA STREET CAR PARK UPGRADE

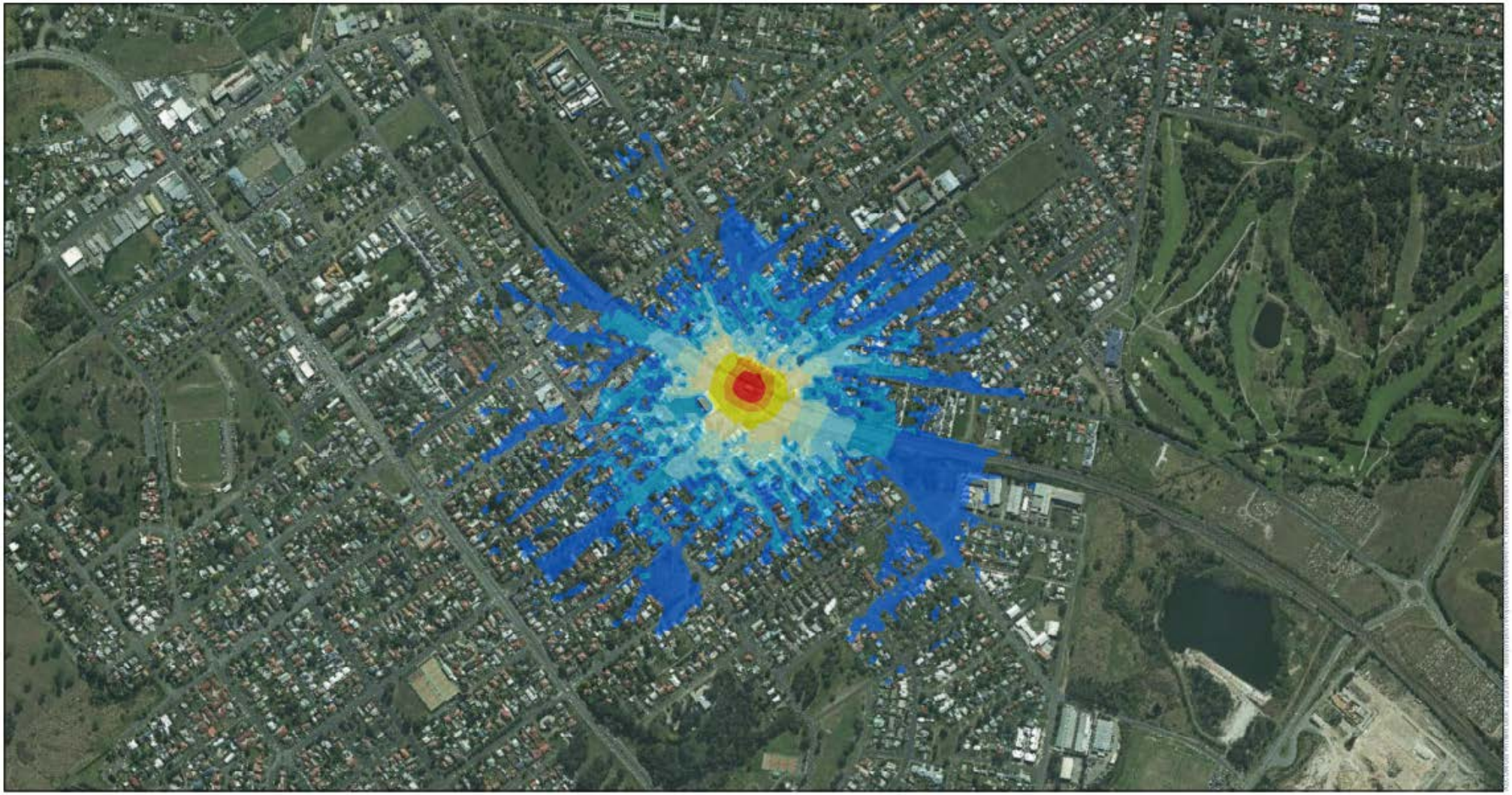
Sub Stage 4A - Reconfiguration of internal station buildings

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75



VICTORIA STREET CAR PARK UPGRADE

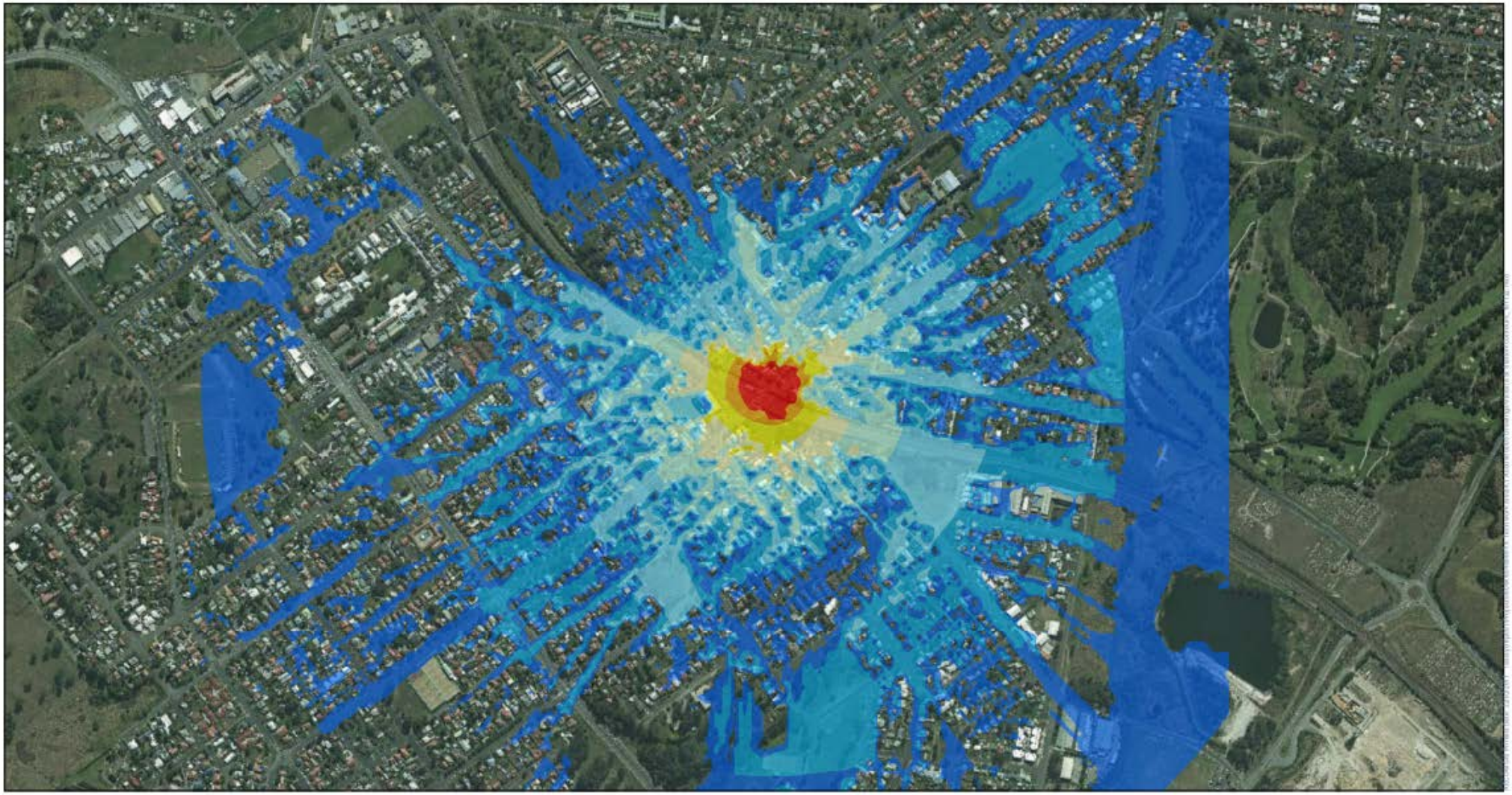
Sub Stage 4B - Refresh of station building including painting works

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75



VICTORIA STREET CAR PARK UPGRADE

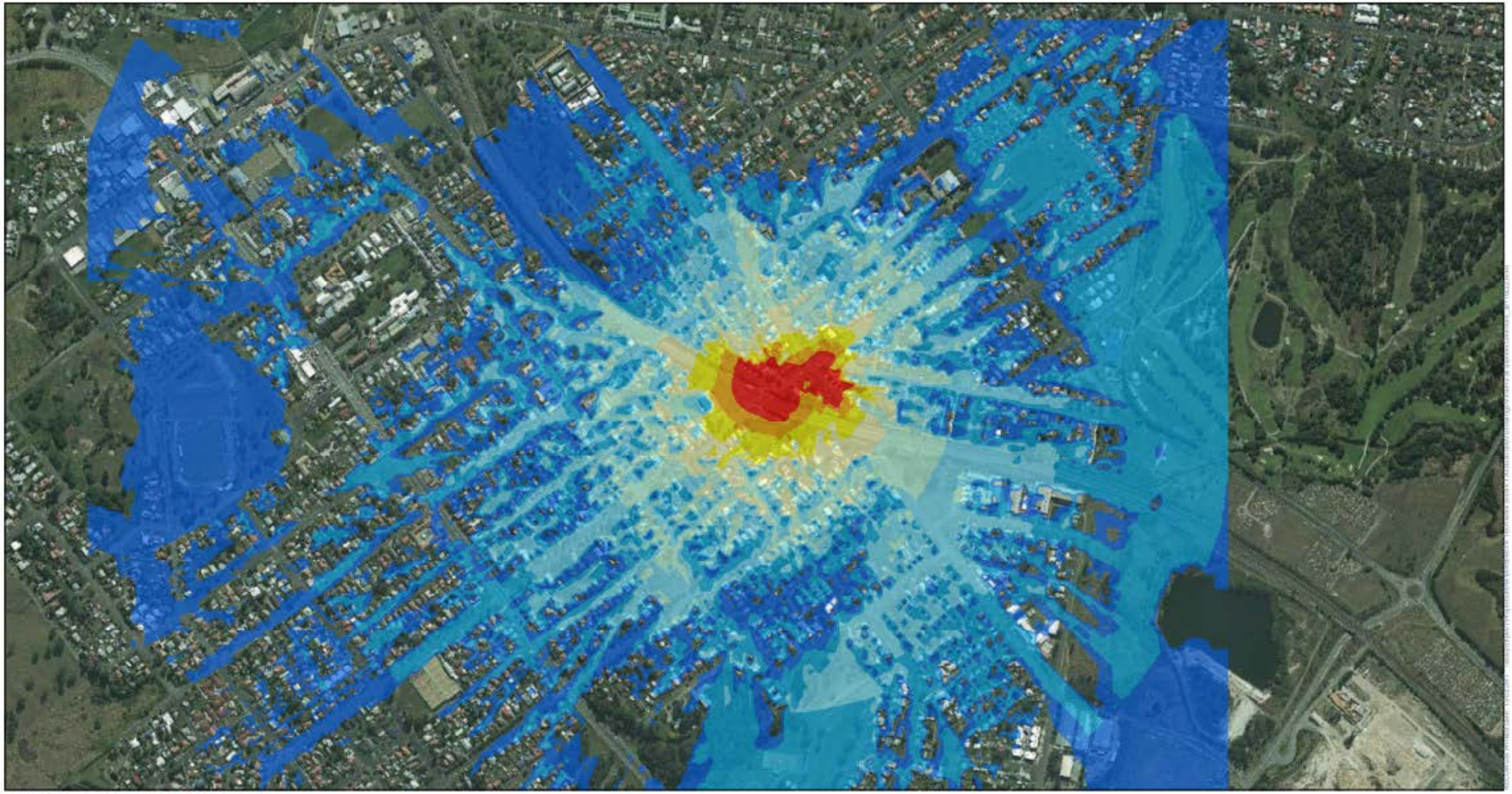
Sub Stage 5A - Taxi zone, kiss and ride, bus stops, bike racks and accessible car spaces

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75



VICTORIA STREET CAR PARK UPGRADE

Sub Stage 5B - Installation of signage & transformer, electrical works, landscaping & trenching

AECOM

0 150 300 m

Sound Pressure Level, L_{Aeq} dB(A)

40 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75